Coeur d'Alene Tribe
Fish, Water, and Wildlife Program

Coeur d'Alene Tribe Trout Production Facility Master Plan

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1.0 Introduction

The Northwest Power Planning Council (Council) receives and reviews proposals to mitigate for fish and wildlife losses and refers approved measures to Bonneville Power Administration (BPA) for funding. The Northwest Power Act (Act) calls on the Council to include measures in its Columbia River Basin Fish and Wildlife Program (Program) to address system-wide fish and wildlife losses. The Act further states that the Council may include in its Program measures that provide off-site mitigation – mitigation physically removed from the hydro project(s) that caused the need to mitigate. The Program includes a goal "to recover and preserve the health of native resident fish injured by the hydropower system, where feasible, and, where appropriate, to use resident fish to mitigate for anadromous fish losses in the system."

Among those recommended measures are off-site mitigation for losses of anadromous fisheries including the measure under analysis in this Coeur d'Alene Tribe Trout Production Facility Master Plan, proposed by the Coeur d'Alene Tribe. To meet the need for off-site mitigation for anadromous fish losses in the Columbia River Basin in a manner consistent with the objectives of the Council's Fish and Wildlife Program, the Coeur d'Alene Tribe is proposing that the BPA fund the design, construction, operations and maintenance of a trout production facility on the Coeur d'Alene Indian Reservation. Measures for establishing a Coeur d'Alene fish production facility have been a part of the Council's Program since 1987.

In 1987, the Council amended the Columbia River Basin Fish and Wildlife Program to include baseline stream survey of tributaries located on the Coeur d'Alene Indian Reservation [section 903 (g)(1)(B)]. Initial work rated reservation streams according to their potential for habitat development for westslope cutthroat trout and bull trout. Ten streams were selected for further study based on geographic location, potential for habitat improvement, road access, and stream gradient. Physical and biological surveys were conducted on the 10 selected streams. These surveys incorporated stream bank and bed stability, riparian condition, land use, urbanization, migration barriers, water quality, stream flow, substrate suitability, channel modification, relative abundance estimates, and macroinvertebrate densities. These physical and biological data were then combined to choose the four streams (Alder, Benewah, Evans, and Lake Creeks also referred to as target tributaries) that offered the best potential habitat and highest fish populations for further study. Since no reproducing bull trout populations have been found in any of the target tributaries the focus of our efforts are on westslope cutthroat trout.

In 1994, the Council adopted the recommendations set forth by the Coeur d'Alene Tribe to improve the reservation fishery. These actions included: 1.) Implement habitat restoration and enhancement measures in Lake, Benewah, Evans, and Alder Creeks; 2.) Purchase critical watershed areas for protection of fisheries habitat; 3.) Conduct an educational/outreach program for the general public within the Coeur d'Alene Indian Reservation to facilitate a "holistic" watershed protection process; 4.) Develop an interim fishery for tribal and non-tribal members of the reservation through construction, operation and maintenance of five trout ponds; 5.) Design, construct, operate and maintain a trout production facility; and 6.) Implement a five-year monitoring program to evaluate the effectiveness of the hatchery and habitat improvement projects. The principles, priorities, and objectives for this mitigation are described in the 1995 Program, Section 10, Resident Fish, specifically Sections: 10.8B; 10.8B.1; and 10.8B.20. The Coeur d'Alene Tribe Fish, Water, and Wildlife Program (FWWP) intends to utilize a trout production facility in part, to restore native fish stocks in tributaries located on the reservation, as well as, provide fish for an interim trout fishery in catch out ponds. This will be completed in conjunction with effective habitat restoration.

The Coeur d'Alene Tribe Trout Production Facility is intended to rear and release westslope cutthroat trout into rivers and streams with the express purpose of increasing the numbers of fish spawning, incubating and rearing in the natural environment. It will use the modern technology that hatcheries offer to overcome the mortality resulting from habitat degradation in lakes, rivers, and streams after eggs are laid in the gravel. Supplementation of native fish stocks in conjunction with effective habitat restoration will be the primary means of achieving these biological goals.

Overarching goals for the program include: 1.) Protection, mitigation, and enhancement of Columbia River Basin native resident fish resources. 2.) Develop, increase, and/or reintroduce natural spawning populations of westslope cutthroat trout into reservation waters. 3.) Provide both short and long-term harvest opportunities for the reservation community. 4.) Sustain long-term fitness and genetic integrity of targeted fish populations. 5.) Keep ecological and genetic impacts to non-targeted fish populations to a minimum.

1.1 SUBBASIN DESCRIPTION

The Coeur d'Alene subbasin lies in three north Idaho counties Shoshone, Kootenai and Benewah. The basin is approximately 3840 square miles and extends from the Coeur d'Alene Lake upstream to the Bitterroot Divide along the Idaho-Montana border. Elevations range from 2,120 feet at the lake to over 7,000 feet along the divide. A portion of the watershed lies within the boundaries of the Coeur d’Alene Indian Reservation.

Coeur d'Alene Lake is the principle waterbody in the subbasin. The lake is the second largest in Idaho and is located in the northern panhandle section of the state. Population centers are located on the Northern most shoreline of Coeur d'Alene Lake (Coeur d'Alene) and at the mouth of the Coeur d'Alene River (Harrison). The lake is located in two Idaho counties: Kootenai and Benewah. The city of Coeur d'Alene is the largest in Kootenai County and Harrison is the second largest in Benewah County. The largest town in Benewah County (St. Maries) lies about 12 miles upstream of Coeur d'Alene Lake on the St. Joe River.

Coeur d'Alene Lake is within the 17,300 square kilometer Spokane River drainage basin. The lake lies in a naturally dammed river valley with the outflow currently controlled by Post Falls Dam. Post Falls Dam controls the level of the St. Joe River at the town of St. Maries, like the lake. At full pool (lake elevation 648.7 meters) the lake covers 129 square kilometers and at minimum pool level (lake elevation of 646.2 meters) the lake covers 122 square kilometers. The lake is 26 miles long and anywhere from 1 to 6 miles wide. The lakes mean depth is 22 meters with a maximum depth of 63.7 meters.

Many tributaries feed Coeur d'Alene Lake. The two main tributaries of the lake are the Coeur d'Alene and St. Joe Rivers that drain the Coeur d'Alene and St. Joe Mountains. Recently completed Geographic Assessments of the Coeur d’Alene and St. Joe river basins describe geologic and geomorphic processes affecting the Coeur d’Alene Lake basin. The underlying geology of much of the basin is primarily Belt meta sediments, but the southern portion of the St. Joe basin and the St. Maries basin have been modified or influenced by intrusions of the granitic Idaho Batholith. These intrusions have resulted in the formation of re-metamorphosed sedimentary rock that tends to be less stable than landforms based primarily on Belt meta sediments. Lower elevations are composed primarily of glaciofluvial deposits.

The watersheds of interest have evolved and adapted to a series of geologic and climatic events, including general regional uplift, volcanism, intrusion of granite materials, and several stages of glaciation and climate change. The historic range of conditions resulted in watersheds and biotic communities that have developed and evolved with an operating range and resiliency that allows them to adjust to both frequent and rare events. Recently, dramatically increased human populations have exerted stresses on the aquatic and terrestrial ecosystems. Anthropogenic changes, such as, urbanization, construction of Post Falls Dam, conversion of forests and wetlands to pasture and agricultural lands, road construction, and introduction of exotic species have disturbed many natural processes of Coeur d'Alene subbasin and their biotic systems.

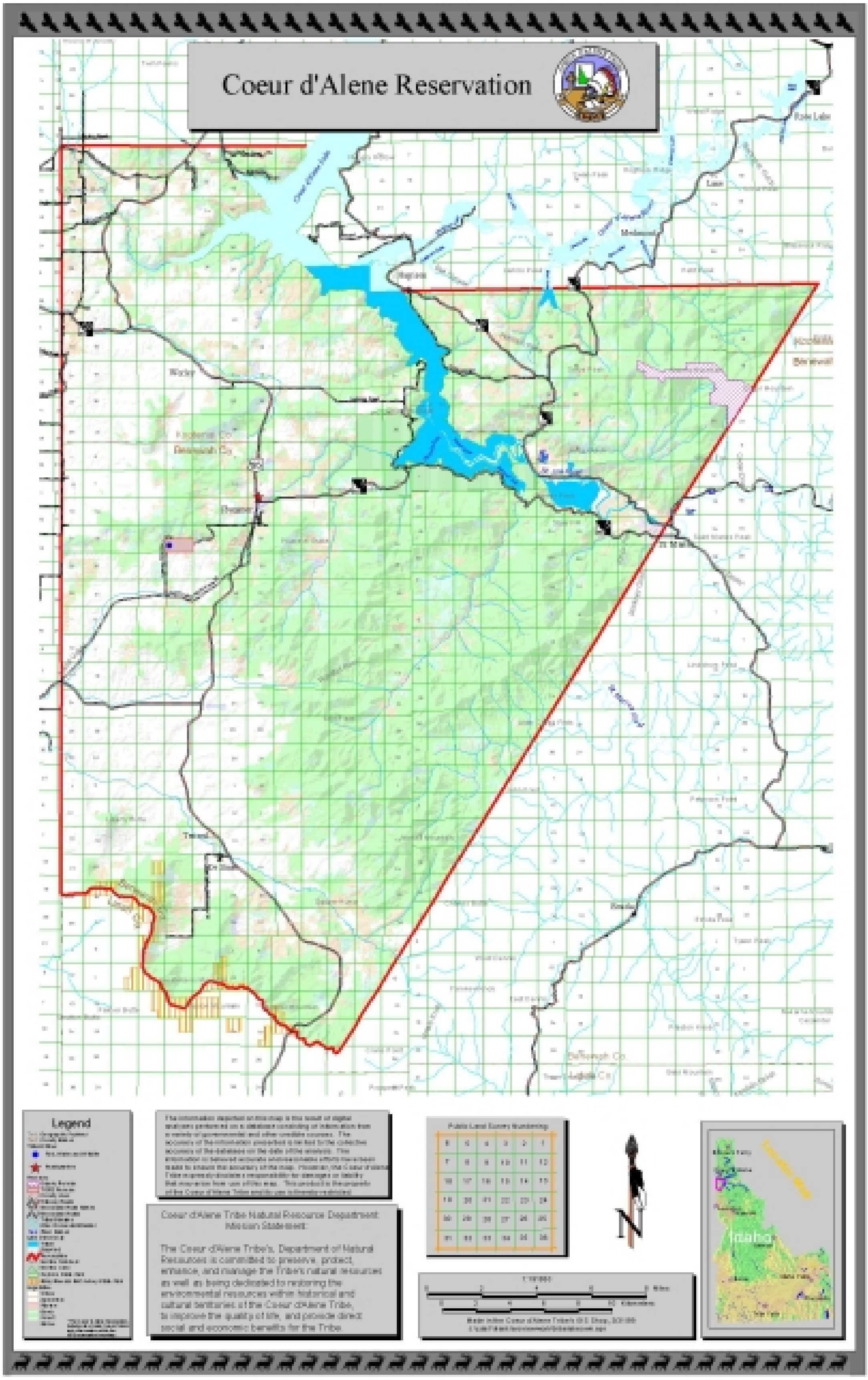

Figure 1.1.1 Map of the Coeur d'Alene Indian Reservation and Study area

The climate and hydrology of the watersheds of the Coeur d'Alene subbasin are similar in that they are influenced by the maritime air masses from the pacific coast, which are modified by continental air masses from Canada. Summers are mild and relatively dry, while fall, winter, and spring brings abundant moisture in the form of both rain and snow. A seasonal snowpack generally covers the landscape at elevations above 4,500 feet from late November to May. Snowpack between elevations of 3,000 and 4,500 feet falls within the “rain-on-snow zone” and may accumulate and deplete several times during a given winter due to mild storms (US Forest Service 1998). The precipitation that often accompanies these mild storms can cause significant flooding because the soils are either saturated or frozen and the rain and melting snow is added directly to the runoff.

Morphology, aspect, and vegetative cover can influence the magnitude and frequency of these peak flow events. Large openings that permit free air movement over the snow pack can accelerate the rate of snow pack depletion. Openings from fires, insects and disease, and wind have always existed in the watersheds and have enhanced this rain-on-snow phenomenon. More recently, however, clearing of land for homesteads, logging, pasture, and agriculture have substantially enhanced this phenomenon. In Lake Creek for example, where nearly 40 percent of the basin area has been cleared for agriculture, peak discharges have increased by an estimated 55% for 100-year events when compared with the pre-settlement period (Peters et. al. 1999). Lesser amounts of forest clearing have occurred in the other Coeur d'Alene subbasin watersheds, suggesting measurable increases in peak discharges for these areas as well.

The runoff period and peak discharge from the lake generally occurs between April and June, but the highest peak flows recorded are from mid-winter rain-on-snow events. Peak flows from the St. Joe and Coeur d’Alene rivers have exceeded 50,000 cfs and 70,000 cfs, respectively. Average monthly discharges from both the St. Joe and Coeur d’Alene rivers range from September lows of between 400 cfs to 500 cfs to April-May highs of 7,000 to 8,000 cfs.

The Coeur d’Alene subbasin can be grouped into four Key Watersheds based on geographic features, known relatively unimpacted areas, other important habitat related to native species and known historic conditions (table 1.1.1). The key watershed groupings are the St. Joe River and tributaries (excluding the St. Maries River), St. Maries River and tributaries, Coeur d’Alene River and tributaries, and Coeur d’Alene Lake and tributaries. Each key watershed is further broken into sub-watersheds for which similar characteristics exist.

Table 1.1.1 Breakdown of vegetative cover per key watershed area in the Coeur d'Alene subbasin.

Cover Type	**Watershed**					
	Coeur d'Alene River	**St. Joe River**	**St. Maries River**	**Coeur d'Alene Lake and Tributaries**	**Spokane River**	**Coeur d'Alene Subbasin Total**
Forest	834146	648633	287006	192244	68926	2030954
Agriculture	17731	8669	10615	53162	46508	136685
Rangeland	62924	46477	13281	23923	23093	169697
Water	6034	1257	35	31236	2411	40972
Wetland	4508	131	221	877	178	5915
Other	28479	87338	1188	5113	10905	133022
Watershed Totals (Acres)	**953821**	**792505**	**312345**	**306555**	**152021**	**2517246**

Twelve native fish species inhabit the Coeur d’Alene Lake basin: northern pikeminnow *Ptychocheilus oregonensis*, redside shiner *Richardsonius balteatus*, torrent sculpin *C. rhotheus*, shorthead sculpin *C. confusus*, speckled dace *Rhinichthys osculus*, longnose dace *R. cataractae*, longnose sucker *Catostomus catostomus*, largescale sucker *Catostomus macrocheilus*, bridgelip sucker *C. columbianus*, mountain whitefish *Prosopium williamsoni*, westslope cutthroat trout *Oncorhyncus clarki lewisi* and bull trout *Salvelinus confluentus*.

Introduced fish species present in the basin include: smallmouth bass *Micropterus dolomieui*, largemouth bass *M. salmoides*, crappie *Pomoxis spp.*, sunfish *Lepomis spp.*, yellow perch *Perca flavescens*, lake superior whitefish *Coregonis clupeaformis*, brown bullhead *Ameiurus nebulosus*, channel catfish *Ictalurus punctata*, tench *Tinca tinca,* northern pike *Esox lucius*, tiger musky *E. lucius x E. masquinogy,* brook trout *Salvelinus fontinalis*, rainbow trout *Oncorhynchus mykiss*, chinook salmon *O. tshawytscha,* cutthroat-rainbow trout hybrids, and kokanee *O. nerka*.

Herptofauna known or suspected to inhabit the Coeur d'Alene subbasin include the long toed salamander *Ambystroma macrodactylum*, Coeur d'Alene salamander *Plethodon idahoensis*, Idaho giant salamander *Dicamptodon aterrimus*, tiger salamander *Ambystoma tigrinum*, garter snake *Thamnophis sirtalis*, western toad *Bufo boreas*, Pacific chorus frog *Pseudacris regilla*, Columbia spotted frog *Rana pretiosa*, and tailed frog *Ascaphus truei*.

Wide spread changes in land-use patterns have caused the decline of many of the more sensitive native species. Bull trout have been listed as threatened under the Endangered Species Act by the USFWS and the status of westslope cutthroat trout is currently under review. Species of concern also include the Coeur d'Alene salamander and the Columbia spotted frog. These changes in land-use patterns are not always to the detriment of native species. Some species like the northern pikeminnow have flourished under the current conditions of the watersheds. Most of the introduced exotic species are also doing well under the current environmental conditions. Northern pike, largemouth and smallmouth bass, chinook salmon, kokanee salmon, as well as, yellow perch and black crappie are all doing well. Historically, cutthroat trout were the most abundant fish species. Today, kokanee salmon are the most abundant fish species in the subbasin.

Wildlife species are abundant within the Coeur d'Alene subbasin. Ungulates consist of two deer species, elk, and moose. Carnivores are widespread and diverse throughout the basin including the lynx, gray wolf, black bear, fishers, martens, and other species. Other important guilds include various waterfowl populations, neo-tropical migratory birds, small mammals, amphibians and reptiles. Mitigation activities are directed at a group of target species intended to represent cover types that were impacted by the development and operation of the Federal Columbia River Hydropower System.

1.2 HISTORICAL AND CURRENT STATUS OF RESIDENT FISH IN SUBBASIN

The annual runs of anadromus salmon and steelhead are now extinct from traditional Coeur d'Alene Tribal fishing areas. This forced the Tribe to rely solely on the resident fish resources of Coeur d'Alene Lake. Subsequent declines in native salmonid fish stocks; in particular, westslope cutthroat trout in the Coeur d'Alene Basin caused the elimination of traditional subsistence fisheries by Coeur d'Alene Tribal members.

Early information on the historic distribution in the Spokane River Basin is based largely on written accounts from primarily Euro-American settlers and oral testimony from Coeur d'Alene Tribal Members. The common theme of these accounts was that cutthroat trout were the most abundant resident fish species. Historic catch estimates of cutthroat trout by the Coeur d'Alene Tribe were estimated at 42,000 fish per year (Scholz et. al. 1985). It is assumed that historically these fish colonized all available habitats around Coeur d'Alene Lake. Nineteen tributary streams totaling 110.3 stream miles located, wholly or partially, on the Coeur d'Alene Indian Reservation were identified as probable historic cutthroat trout bearing streams (Graves et. al. 1990). Total stream miles of available habitat is underestimated because this figure only includes mainstem reaches. We know that small intermittent tributaries serve as important spawning and rearing areas. For example, in Benewah creek the mainstem is 14.7 miles long but there are 24.1 miles of fish bearing water when intermittent tributaries are taken into account (Peters et. al. 1999).

Graves (1990) conducted aerial surveys on water of the Coeur d'Alene Indian Reservation and nineteen streams were identified as having historic potential for trout. Currently, nine streams (26.7 stream miles) were identified as having conditions that would result in little or no use by cutthroat trout (Lillengreen et. al. 1991). This is a 24% reduction in geographic distribution. This also means that nine genetically distinct population groups have been lost. Cumulative impacts from construction of Post Falls Dam in 1906; major changes in land cover types from primarily forested areas to forests with recent and recovering clearcuts, agricultural and pasture lands, urban development, roads, mining and open range land; and introduction of exotic fish species are cited as the main reasons. The ten remaining streams were sampled for cutthroat trout. Reproducing populations were found in nine of the ten streams (Lillengreen et. al. 1993).

However, eight of the nine populations were severely reduced when compared to other Idaho streams. Furthermore, growth rates were low when compared to other Idaho streams. A more detailed assessment has been completed on the condition of the four best streams (Lake, Benewah, Evans and Alder creeks) within the Reservation.

Fish traps were installed in the four target tributaries to assess migratory patterns, reproductive cycles, distribution, catch per unit effort, and relative abundance. No adfluvial fish were caught in Evans and Alder Creeks since trapping began in 1993. Trap data from Evans creek indicate that the migratory population has been lost. A migration barrier exists in Alder creek thus; it is suspected that adfluvial fish were never present. A total of 907 cutthroat trout were caught in the lower Lake Creek trap in 1996, 273 were caught in 1997 and 1277 were caught in 1998. Twenty-eight (3% of total catch) adult fish (age IV or older) were captured in 1996 and nine (3%) were captured in 1997 and sixty-three (5%) were captured in 1998. Although total numbers varied considerably among years, catch per unit effort was similar (12.4 fish/day and 7.8 fish/day, respectively). Trapping success in Benewah Creek for the years 1996-98 was considerably lower than in Lake Creek. Only one cutthroat trout was caught in 1996 (0.04 fish/day) while a total of 26 were caught in 1997 (0.7 fish/day) and 535 were caught in 1998. Adult fish (age IV or older) accounted for 27 percent of the catch (n=8) in 1997 and 14.5 percent (n=78) in 1998. Above normal precipitation and runoff greatly reduced the effectiveness of trapping efforts and, in part, account for the variation in numbers of trout caught.

Resident juvenile and adult and adfluvial juvenile cutthroat trout populations were estimated in 1996, 1997, and 1998 using the removal-depletion method (Seber and LeCren 1967, Zippen 1958) *in* Vitale et. al. (1999). Cutthroat trout greater than 200 mm in length were tagged other species such as longnose dace, redside shiner, longnose sucker, and sculpin (sp.) were considered incidental catch and were only counted. Sample sites within each reach were selected to include habitat types representative of the reach as a whole. Sites were sampled in the summer to quantify the abundance and distribution of fishes during base flow conditions (July 30 – August 22, 1996 and June 6 – July 11, 1997). An additional sampling effort in the fall (September 11 – October 28, 1996 and August 11 – September 11, 1997) attempted to capture young of the year fish that had been missed during the summer sampling period and to document fish migration in response to changing water quality conditions. The mean annual populations of cutthroat trout in the target tributaries for 1996-1998 is 808 for Alder Creek, 5,553 for Benewah Creek, 2,675 for Evans Creek and 4,946 for Lake Creek (Vitale et. al. 1999).

General patterns of cutthroat trout abundance and distribution vary among the target watersheds and among years, but seem to be highly correlated to seasonal changes in water quality and quantity. Cutthroat trout are sporadically distributed in the Lake Creek, Benewah Creek, and Alder Creek watersheds during both the summer and fall seasons. Abundance in the second order tributaries of Lake Creek and Benewah Creek are consistently much higher than in adjacent mainstem reaches, despite the effects of low flow conditions. During base flow conditions, for example, cutthroat trout have been known to crowd into small, isolated pools (>15 fish/m^2) located in cool tributaries, rather than face conditions of high water temperatures in mainstem reaches. In contrast, favorable water quality conditions in Evans Creek result in a relatively even distribution of cutthroat trout. Cutthroat trout abundance is consistently lowest in Alder Creek.

Surveys conducted in 1997 showed that cutthroat trout abundance increased dramatically during the fall sample period. Fall surveys were conducted following fry emergence, which occurs in late June to early July, and young of the year fish accounted for most of the seasonal variation in abundance within sites. Young of the year fish were found principally in small tributaries, which supports the hypothesis that the majority of spawning activity takes place in second order streams in these watersheds.

It is suspected that young of the year fish have a greater chance of mortality due to stochastic events than due older fish. Young of the year fish tend to be found in greatest numbers in isolated pools where space is limited. Given the variable environmental conditions typical of this geographical area these pools could dry completely and 100% mortality would occur.

Reiman and Apperson (1989) estimated that populations considered as “strong” (greater than or equal to 50% of historical potential) by Idaho Department of Fish and Game (IDFG) remained in only 11% of the historical range within the State of Idaho. On the Coeur d’Alene Indian Reservation none of the populations are considered “strong”. Idaho biologists also believed that less than 4% of the historical range supported strong populations not threatened by hybridization. (Reiman and Apperson 1989). Preliminary genetic analyses of the cutthroat populations show that relatively pure stocks exist in reservation waters. Only minimal amounts of hybridization with rainbow trout have occurred. Some populations show no hybridization at all. Thus, it could be theorized even though the populations are not “strong” they are not threatened to a large extent with hybridization. Implications here are that if the effect of limiting factors can be reduced genetically pure populations would have a chance to recover.

2.0 PROPOSED ACTION

To meet the need for off-site mitigation for fish losses on the mainstem Columbia River in a manner consistent with the objectives of the Council’s Program the Coeur d'Alene Tribe is proposing that the BPA fund the design, construction, operation, and maintenance of a trout production facility on the Coeur d'Alene Indian Reservation. The Coeur d'Alene Tribe Trout Production Facility is intended to rear and release westslope cutthroat trout into rivers and streams with the express purpose of increasing the numbers of fish spawning, incubating and rearing in the natural environment. It will use the modern technology that hatcheries offer to overcome the mortality resulting from habitat degradation in lakes, rivers, and streams after eggs are laid in the gravel. Supplementation of native fish stocks in conjunction with effective habitat restoration will be the primary means of achieving these biological goals.

The Coeur d'Alene Tribe is also proposing that the BPA fund the annual production of up to 10,000 rainbow trout for release into five isolated catchout ponds for a ‘put and take’ sport fishery on the reservation. This fishery will be used to supplement subsistence harvest needs for tribal members. It will also provide an alternative sport fishery for the surrounding community. These activities will also reduce fishing pressure on weak native stocks allowing recovery. When self-sustaining natural fish populations can support all subsistence and sport harvest needs this phase of the program will be discontinued.

The Coeur d'Alene Tribe also proposes that the BPA fund a monitoring and evaluation program to evaluate the effectiveness of the Trout Production Facility in meeting its goals and objectives with respect to the following performance standards and indicators: 1) Provide predictable, stable, and increased opportunity for harvest, 2) Achieve genetic and life history conservation, 3) Enhance tribal and local economies, 4) Fulfill legal/policy obligations, 5) Provide fish to satisfy legally mandated harvest, 6) Achieve within-hatchery performance standards, 7) Restore and enhance naturally spawning populations. These performance standards and indicators are further described and defined in the September 15th, 1999 Draft *Artificial Production Review Volume I Report and Recommendations of the Northwest Power Planning Council*, Council document 99-13.

2.1 CONCEPTUAL HATCHERY DESIGN

J-U-B ENGINEERS INC. was contracted by the Coeur d'Alene Tribe to complete the conceptual design phase of the mater plan. They further subcontracted part of this to John Cussigh of JC Aquaculture Consultants. The following is a summary of the conceptual hatchery design. A more detailed description can be found in Appendix (A). The Coeur d'Alene Tribal trout production Facility will be built to hold westslope cutthroat trout broodstock on a year-around basis and produce up to 100,000 fingerling cutthroat trout and 10,000 rainbow trout for stocking in catchout ponds.

The facility will be located on approximately 8 acres of land and will contain an indoor central incubation and early life stage rearing facility. This building will also house the main offices, wet and dry analytical laboratory, and interpretive center. Four outdoor production raceways will be constructed to hold juvenile fish until ready to out plant. In addition, four raceways will be constructed to hold broodstock from each of the four tributaries. The support of this broodstock program will be the number one priority at the new facility. Four offsite satellite acclimation facilities will also be constructed to hold out planted fish for volitional releases.

Hatchery Building

A new 3,150 square-foot hatchery building will be constructed and will hold the central incubation facility, the early life stage development troughs. Well water will be filtered, aerated, and chilled to 45-50^{o}F prior to release into the hatchery facility. 20 gpm will be needed for incubation and 140 gpm for early life stage rearing. Four eight tray vertical incubators will be used to hatch the fry. Sixteen troughs will hold juvenile cutthroat trout while three of the troughs will hold rainbow trout. The rainbow trout will be held in water at a slightly higher temperature (58^{o}F) to promote faster growth. Each trough will be plumbed for both reuse and direct discharge. An isolation unit will also be housed adjacent to the building in a partially covered area made by extending the roofline of the main building. This area will house four 4-ft. diameter and four 6-ft. diameter round tanks that will be used to hold and observe newly recruited wild broodstock prior to releasing them into the broodstock raceways.

Production Raceways

Approximately eight months after the fry are started on feed they will be moved into one of four production raceways where they will be grown to the planting size of 4 inches. Their growth will be controlled through manipulation of water temperature and feeding so as to mimic wild growth rates. Each production raceway will have inside dimensions of 6.5 ft. by 50 ft. by 2.5 ft. water depth. A two pass system will be used in which water from the upstream raceway is aerated and used in the downstream raceway. Total flow for all four production raceways will be limited to 600 gpm. Raceways will also be covered in order to preclude excessive temperature gain in the downstream raceway. These raceways will also have baffles to create eddies and higher velocity zones in order to create a superior cutthroat trout growout scheme.

Broodstock Raceways

Cutthroat broodstock will be collected from each of the four target tributaries. These fish will be collected as fry and held until they are ready to spawn. These fish will be quarantined and held for six the twelve months prior to being transferred into the broodstock raceway. Each broodstock raceway will be 12 ft. wide by 45 ft. long and 5 ft. deep with rounded ends to promote flow circulation. A wooden dividing baffle and two air lifts will current throughout he raceway. Approximately 25 gpm of treated water chilled to 60^{o}F will be supplied to each raceway when it is fully loaded with about 1,400 pounds of cutthroat broodstock (500 fish @ 2.8 pounds apiece). Shading for each raceway will also be provided to help maintain optimum water temperatures. Each raceway will be plumbed for direct discharge and discharge to the re-use system. The proposed raceway design will result in broodstock raceways that are essentially self-cleaning.

Rainbow Trout Ponds

Approximately 15,000 rainbow trout fry, that have been hatched and started on feed in the hatchery during winter months, will be placed in one of two earthen growout ponds when they reach a size of about 1.8-inch (2.2 lbs. per 1000) in early Spring. They will be kept in the growout ponds for an additional period of about 1.5 years, at which time (year 2) they will be outplanted into the catchout ponds at a size of about 12.5 inches. The 0.33 acre (AC) rainbow trout ponds will be approximately 75 feet wide and 190 feet long each. Total pond depth will vary from 15 ft at the supply end to 16 ft at the drain end to facilitate drainage. These deep ponds will help to attenuate summertime water temperatures and provide a more hospitable environment for the rainbow trout. The treated and disinfected reuse water will be distributed at a rate of about 20 (+) gpm to each pond. In addition, untreated surface water from Rock Creek will be used to supplement these flows during the months of October through March, or April, depending on availability. Supplemental aeration is also envisioned for these ponds during the summer months. It must be carefully designed, however, so as not to induce destratification, and thus negate the effect of the deeper water column. Overflow from these ponds will not be reused but piped directly to the effluent pond, and then discharged from the site.

Satellite Acclimation Ponds

One flow through pond approximately 10-15 ft. deep by 20 ft. long and 20 ft. wide will be constructed in each of the target watersheds. Approximately 25,000 4-inch fish will be placed into these ponds in early March where they will be fed until the spring migration period (May-June) where they will be left for volitional migration to Coeur d'Alene Lake.

2.2 NEED FOR ACTION

Action is needed to mitigate for losses of anadromous fisheries caused by the construction and operation of the Federal Columbia River Power System by restoring native resident fisheries.

2.3 PURPOSES

The following purposes and/or goals will be considered in evaluating the proposed action and alternatives:

- Cost and administrative efficiency;
- Consistency with the Northwest Power Planning Council's Program;
- Complements activities of fish and wildlife agencies and appropriate Tribes;
- Consistency with the legal rights of the Coeur d'Alene Tribe and appropriate Tribes in the region;
- Avoids or minimizes environmental impacts;
- Results in sufficient returns of native westslope cutthroat trout adults to begin limited harvest by the year 2012;
- Increases native westslope cutthroat trout populations to sustainable and harvestable population levels by the year 2016; and
- Provides an alternative rainbow trout resource for harvest, to protect weak native fish stocks.

Consistent with the Northwest Power Planning Councils Fish and Wildlife Program and September 15th draft of the *Artificial Production Review*, artificial production will be used as a tool to address specific biological and management issues. The intended function of this facility incorporates three of the five Council defined purposes for artificial production. First, the facility will be used for mitigation of lost anadromous fisheries caused by the construction and operation of the Federal Columbia River Power System through restoration of native resident fisheries. In the blocked area above Grand Coulee Dam, habitat has been irrevocably lost due to human activities resulting in the elimination of anadromous salmon populations. Compensation for the lost habitat capacity through substitution with resident fish species in permanently blocked areas is consistent with the Northwest

Power Planning Councils Fish and Wildlife Program. Second, the hatchery will be used as a tool in watershed restoration programs where supplementation will be used to seed barren habitat, provide a survival advantage to depressed stocks and speed rebuilding to carrying capacity. Thus, rebuilding a population to harvestable levels as quickly as possible. Lastly, the facility will be used for augmentation of harvest opportunities through "put and take" fisheries in isolated catchout ponds on the Reservation. Due to limited natural production traditional subsistence harvest has been eliminated on the Reservation. This facet of the program is directed at increasing harvestable numbers of fish as well as, harvest opportunities. Commensurate with "put and take" harvest there should be a simultaneous reduction in harvest pressure on the weak native fish stocks in the target tributaries.

2.4 ALTERNATIVES TO THE PROPOSED ACTION

The alternatives including the proposed action involves the leasing of trust property from the Tribe, constructing a trout production facility and developing a hatchery program to raise wild origin westslope cutthroat trout to be outplanted in the wild. As well as, raising domestic rainbow trout for a short-term alternative subsistence fishery. The supplemented westslope cutthroat fish stocks will be of wild origin and outplanting will occur in adherence to the strict guidelines described later in this document. The rainbow program will be based on purchased eggs available on a year around basis. Rainbow trout will be stocked into isolated trout catchout ponds located on the Reservation. The Rainbow trout component of the Coeur d'Alene Tribe Fish, Water and Wildlife Program is to be used only in sport fishing programs.

The first alternative to the proposed action is to drop the rainbow trout component from the production facility and purchase them from a local vendor for stocking in the catchout ponds. The second alternative is the no action alternative. No action means not constructing the facility and relying on habitat restoration to satisfy production needs. These three alternatives will be evaluated in detail during the NEPA process. Many factors will be looked at including cost-efficiency.

2.5 SITE SELECTION

On the Coeur d'Alene Indian Reservation, supplementation activities would involve stocking fish into habitats that contain depressed but existing natural fish populations. Unlike many traditional hatchery programs, the objective of supplementation here is to increase the abundance of a naturally reproducing fish populations and therefore, is oriented toward maintaining the natural biological characteristics of the population and reliance on the rearing capabilities of the natural habitat. This need to maintain the natural biological characteristics of each individual fish stock sets limits on how the hatchery will operate. These limits also confine us to only a few specific sites for hatchery construction.

- The hatchery must be easily accessible during all times of the year. This means that large trucks (semi tractor and trailer) must be able to service the hatchery during all seasons of the year. Staff needs to be able to access the compound on a daily basis during all seasons of the year.

- The hatchery must be centrally located in order to minimize stress on the fish during transportation this is both at the egg stage and juvenile stages. Having a centrally located hatchery facility also will allow potential for other related activities, such as, developing an interpretive center for showcasing the tribes efforts in fish management and recovery.

- The hatchery must meet the goals of the program established by tribal council for the protection, conservation, and enhancement of native fishes.

- The hatchery must be able to meet the needs of the fish during all life stages. This means that a long-term cool clean pathogen free water supply, unlikely to be impacted from surrounding agricultural and urban development, needs to be readily available.

- Reliable power supply and access
- Available effluent discharge point (stream, canal, etc.).
- The hatchery must meet the mandates set forth in the threatened and endangered species act for all fish species cultured at the facility.
- The selected hatchery location must meet all requirements of a cultural resource review.

One site, T633 along Rock Creek, satisfied most of the selection criteria. The Rock Creek Site is centrally located on 160 acre T633 (Tribal Trust Property) parcel between the towns of Worley and Plummer. The general topography is flat with areas that are seasonally flooded. Access to this site is very convenient being located within ½ mile of U.S. Highway 95. Access during the winter would be easily maintained. A hatchery located at this site could also be developed into an interpretive center showcasing the Tribe's commitment to fisheries management and conservation. Fish distribution from this site would be good because travel time and distance would be short. Staff would not have to live on-site due to the proximity to the towns of Worley and Plummer. Operations and Maintenance costs would be minimized at this site.

One of the goals of the program is to protect, conserve and enhance the native fishes occurring on the reservation. A fish survey in Rock Creek revealed the absence of salmonid species. Historically this stream had rainbow trout but water quality (temperature and flow) limits the range of this species now. Problems with placing a hatchery on a stream that contains native fish of the same species would not occur at this site. No problems would occur if fish escaped from the hatchery.

Water needs for the hatchery could be served not only by diverting water from the stream but also through ground water. Two wells are already developed at this site. Water quality may or may not be an issue that has yet to be determined. Given the absence of threatened and endangered species in this system no problems with the endangered species act would occur.

Water Quantity/Quality on T633

Water Quantity

J-U-B ENGINEERS was hired to research the site feasibility of the proposed hatchery site. Given time restraints a site feasibility study was conducted on only the preferred site. A final report is included in Appendix (B). This section only summarizes the results.

There are many other positive qualities for development of a hatchery on this site. Those positive qualities include:

- Good topography for hydraulic flow path of water in and out of the hatchery.
- Good topography for effluent discharge and effluent polishing.
- Enhanced wetlands creation and mitigation due to the existing wetlands on-site.
- The Rock Creek flows are significant and available six to nine months out of the year to supplement a groundwater supply system.

J-U-B is evaluating Rock Creek based on its ability to provide flow to the hatchery for 6 to 9 months of the year. The Tribe has collected Rock Creek's temperature and flow data for some time, although a full year's data does not exist. The temperature and chemistry data that has been received from the Tribe shows Rock Creek to be a reasonable source option for a water supply to the hatchery.

The on-site test well is estimated to be able to supply water in excess of 100 gpm. In addition to the rate of flow available, the sustainability of the supply is of greater importance. To evaluate the sustainability of the groundwater source, a long-term pump test was conducted on the test well. The results of this analysis show that there is low potential for the aquifer to serve as the sole groundwater supply source for the proposed hatchery. Using a delivery rate of 60 gallons per minute for six months per year, it has been shown that water levels will continue to decline below acceptable levels after a period that has been estimated at one to three years. An examination of the geology and existing hydraulic gradient, in conjunction with recharge values from a nearby basin, has provided an estimate of the sustainable yield. Based on this information, it has been estimated that the sustainable yield for a six-month pumping period is 20 gallons per minute. This is less than the minimum required groundwater supply for hatchery purposes.

In order to fulfill the flow requirements, additional groundwater resources or other water sources in addition to Rock Creek need to be identified. On initial examination, the adjacent groundwater basin may have the ability to meet these flow requirements. The approach would be to plan for a number of small wells in the 20 gpm size range in a couple of off-site areas. These wells would be able to provide long-term sustainable production by not exceeding the natural recharge rates for the area each withdraws from. These additional field investigations, test wells, and test pumping activities is being conducted to evaluate the adjacent basin's potential. .

It appears that the potential for adequate water supply exists for this site through a mix of surface and ground water to support the operation of the hatchery. The hatchery life support engineer, John Cussigh has designed a process that will adequately produce the minimum production goal for the Coeur d'Alene Tribe utilizing 60-gpm supply of water year round. Development of a groundwater supply system consisting of two on-site and four off-site wells and construction of a diversion and desilting structure for the use of Rock Creek will be mandatory in order to assure the viability of hatchery operation for the long term. There are risks with this approach but it is J-U-B ENGINEERS opinion that this site is excellent from many standpoints and it is feasible for the long term provided that the well field expansion as described above is successfully developed.

Water Quality

Specific physical and chemical characteristics of the water from the test well were measured with the following results(table 2.5.1)

Table 2.5.1 Water quality test results from test well on T633 compared to suggested water quality criteria for optimum health of salmonid fishes. Concentrations are in mg/l.

	Optimum Criteria			Measured Values	
Source	Wedemeyer, 1977 from Piper, 1982	Larsen, H.N. from Piper,1982	ADFG from Senn, 1984	STL*	TrecLen Lab
Parameters					
pH	---	6.5-8.0	6.5-8.0	7.1	7.1
Conductivity	---	---	---	124.4	124.4
D.O.	---	>5.0	>7.0	5.71	5.71
Temperature	---	---	0-15 C	11.97° C	11.97°C
TDS	---	10-1,000	<400.0	100	125
TSS	<80	---	<80.0	2.70	---
Turbidity	---	<2,000	---	1.19 NTU	1.19 NYU
Ammonia	<0.0125	---	<0.0125	<0.010	<0.010
Chloride	---	---	<4.0	0.630	0.5
Fluoride	---	---	---	0.365	0.350
Nitrate	---	<3.0	<1.0	0.090	0.10
Nitrite	<0.06	---	<0.1	<0.005	<0.02
Sulfate	---	---	<50.0	1.74	<2.0
Alkalinity	---	10-400	undetermined	75	67.7
Aluminum	---	---	<0.01	<0.010	<0.02
Arsenic	---	---	<0.05	<0.020	<0.002
Barium	---	---	<5.0	0.012	0.015
Cadmium	<0.0004	---	<0.0005	<0.001	<0.0004
Chromium	---	---	<0.03	<0.002	<0.003
Copper	<0.006	---	<0.006	<0.002	<0.0009
Iron	---	<0.15	<0.1	0.016	<0.01
Lead	<0.03	---	<0.02	<0.001	<0.004
Magnesium	---	needed	<15.0	4.03	5.0
Manganese	---	<0.01	<0.01	0.004	<0.004
Mercury	<0.002	---	<0.0002	<0.0002	<0.0001
Nickel	---	---	<0.01	<0.005	<0.003
Potassium	---	---	<5.0	1.58	1.0
Selenium	---	---	<0.01	<0.002	<0.002
Silver	---	---	<0.003	<0.001	<0.001
Sodium	---	---	<75.0	6.76	7.0
Zinc	<0.03	<0.050	<0.005	0.015	0.017
* STL = Spokane Tribal Lab					

It appears that zinc is the only parameter that violates any of the suggested values for water quality. However, it is within the range suggested by Piper et.al. (1982).

3.0 LIMITING FACTOR ANALYSIS FOR ALL AQUATIC RESOURCES AND WESTSLOPE CUTTHROAT TROUT

The following is a summary of the limiting factor analysis (Peters et. al. 1999) conducted by the Coeur d'Alene Tribe Fish, Water and Wildlife Program as well as other sources from the region.

3.1 GENERAL THREATS TO ALL AQUATIC RESOURCES

There are four major factors affecting native aquatic species defined in this report: habitat degradation, passage barriers, hybridization and competition with exotics, and harvest. Any number or combinations of factors are present in the Coeur d'Alene Lake. The information presented is summarized from the following documents: *Forest Service Biological Assessment of the St. Joe River and North Fork Clearwater River Basin* (1998), *Draft Coeur d'Alene Basin Problem Assessment* prepared by the Panhandle Bull Trout Technical Advisory Team (1998*), Conservation Assessment for inland cutthroat trout* prepared by the Forest Service (1995), and the *Stock Assessment of westslope cutthroat trout on the Coeur d'Alene Indian Reservation* prepared by Peters and Vitale (1999) and does not represent an original literature review as such.

3.1.1 HABITAT DEGRADATION

<u>Fire</u>
Recent evidence suggests that successful fire suppression since the 1930's may be currently resulting in more intense, catastrophic fires. Past management activities and successful wildfire control have caused a shift in forest species composition and stocking levels, predisposing forests to large scale mortality. Drought conditions can further dispose these forests to increased wildfire incidence and intensity, with the potential for significant negative impacts on water quality and fish habitat. Large wildfires (during 1910 and the 1930's), and numerous smaller fires, have burned in the Coeur d'Alene Lake basin in this century. Large fires have often left riparian vegetation intact along larger streams, but accounts of the 1910 fire from the St. Joe watershed documented significant burning of riparian areas along some streams. Intense fires may increase natural sediment delivery to streams, when hydrophobic soils are created. At the same time, fires can significantly increase recruitment of large woody debris to stream channels. Where post-fire salvage operations have removed woody debris from streamside areas, or created other disturbances such as roads and fire breaks impacts to fish may be increased (Rieman and Clayton 1997). Large stand replacing fires burned through a considerable portion of the upper St. Joe watershed, including riparian areas, yet this area is the largest remaining stronghold for native trout in the Coeur d'Alene Lake basin.

<u>Roads</u>

Road development in the basin is considerable, and includes Interstate 90, five state highways, numerous county and municipal roads, and an extensive road network constructed for forest product removal. Roads and railroads have had significant impacts on stream habitats in the Coeur d'Alene Basin through channelization of streams, encroachment on floodplains, destruction of riparian zones, creation of migration barriers for fish, through sediment delivery associated with construction and failures, and altered runoff patterns. Those areas with the highest density of roads occur in areas managed primarily for timber production. Some roads initially constructed for timber harvest are now used mainly for recreational access, some are regularly used for land management purposes, and still others have been abandoned and/or no longer maintained. On slopes, roads intercept the downward movement of subsurface water and cause it to flow rapidly on the surface. Road location and construction has created erosion rates far beyond those under which the watersheds and streams evolved. Furthermore, this road system has been constructed in many of the most sensitive locations (floodplains, and unstable land types) within the watersheds. The density of unimproved roads exceeds 2.5-miles/mile^2 in most of the subbasin watersheds (Vitale personal comm.).

Land management and access roads paralleling tributary streams are common and are typically more prone to failure and sediment delivery to streams. These roads tend to constrain channel meanders, reduce floodplain capacity, reduce or eliminate riparian areas and limit large woody debris recruitment. Streamside roads are vulnerable to failure during high flows and are significant sources of sediment to stream channels. Stream crossings may result in channel constrictions and impede water movement through floodplains, and can increase deposition on the upstream side and erosion on the downstream side of a crossing. Over 50% of the tributaries (second order and larger) to the St. Joe, St. Maries, and Coeur d'Alene rivers have significant reaches which are significantly affected by roads in floodplains or adjacent to stream channels.

Timber Harvest

Timber harvesting activities in the Coeur d'Alene Lake basin have included clear cutting, partial cutting, thinning, fertilization and prescribed burning. The yarding or skidding of trees varies from ground-based operations and cable systems to aerial approaches with helicopters. Impacts from timber harvest include streams with decreased large woody debris (from log skidding directly in streams and riparian harvest), and lack of recruitable large woody debris and increased temperatures (from harvest of riparian forests). Splash dams were used in several streams (most notably Marble Creek in the St. Joe watershed) and created significant changes to stream channels and fish habitat by creating migration barriers and scouring channels with regular releases of large flows of water and logs. Current impacts of timber harvest on native trout have been reduced with implementation of forest practice rules requiring leave trees in riparian areas, prohibiting equipment in or near streams, and controlling erosion from roads, trails and landings. However, the current leave tree requirement does not adequately protect temperature in all cases (Zaroban 1996). Other impacts of timber harvesting include decreased slope stability and hydrologic alteration.

Mining

Placer mining in streams and valley bottoms has had serious negative effects on native trout in the Coeur d'Alene Basin. This type of mining is associated with increased sediment load, substrate disturbances, resuspension of fine sediments, channelization, bank destabilization, and removal of large woody debris. Streams that have been mined usually lack habitat complexity, large woody debris, and suitable spawning and wintering habitat (Nelson et al. 1991). Revegetation of dredge piles may be slow and sparse, creating a long-term potential for sedimentation (Levell et al. 1987, Nelson et al. 1991). Placer mining has significantly impacted streams in the Beaver and Pritchard Creek drainages in the North Fork Coeur d'Alene watershed, and the Emerald and Carpenter in the St. Maries watershed. Some placer mining has occurred in upper St. Joe tributaries, including Heller and Sherlock creeks, but impacts appear to be less severe in those streams.

Mine tailing dams, waste dumps and diversions can provide barriers to native trout migratory corridors and spawning sites. Toxic constituents (such as heavy metals) arising from historical activities can block migratory corridors or kill life stages of native trout. Prior to establishment of the Clean Water Act, the entire South Fork of the Coeur d'Alene River from Wallace downstream to the mainstem Coeur d'Alene River, and the mainstem downstream to Coeur d'Alene Lake, were so polluted from mining and other wastes that resident fish were unable to survive (Ellis 1932). Portions of the South Fork still do not support coldwater biota due to metals contamination, and the Bunker Hill Superfund Site centered at Kellogg is one of the largest in the nation. Clean-up projects and the cessation of much of the mining and all of the smelting operations have allowed some recovery in several stream reaches to the point where at least some fish and other coldwater biota are supported.

Agriculture

Agriculture activities such as livestock grazing and crop production can result in increased nutrient levels and increased sediment delivery to the streams from bank and channel alteration, and riparian damage. Establishment of drainage districts along the lower St. Joe and Coeur d'Alene rivers has resulted in reduced floodplain capacity, channel alterations, and migration barriers. In the Coeur d'Alene Lake basin livestock grazing is generally confined to the lower river valley bottoms, and livestock grazing is generally not considered to be a significant factor affecting native trout distribution. Livestock grazing along the St. Maries River and some of its tributaries is likely interfering with successional processes which would lead to more shade (which tends to lower water temperatures) and stream bank stability.

Row crop agriculture is most common on the Palouse area, where streams drain into Coeur d'Alene Lake, and along the lower river valleys. Historically, large amounts of fine sediment were delivered to streams from row crop agriculture. Changing practices, implementation of BMPs, and changes in crops and field cover have helped to reduce fine sediment delivery however, it is still major problem in the Lower Coeur d'Alene River and smaller west side tributaries of Coeur d'Alene Lake. High percentages of fine sediment in spawning reaches resulting from agriculture activities probably greatly reduce spawning success of native trout in tributary streams located on the Reservation.

3.1.2 PASSAGE BARRIERS

Barriers caused by human activities limit population interactions and may eliminate life history forms of native trout. Where isolation has occurred, the risk of local extinction due to natural stochastic events increases (Horowitz 1978). Restoring and maintaining connectivity between remaining populations of native trout is believed to be important for the persistence of many of the native fish species especially in the Coeur d'Alene Basin. Native trout that migrate downstream of fish passage barriers are unable to contribute to the trout population upstream. In systems with dams, this loss can be quite significant. The only known dams affecting fish migration in the Coeur d'Alene Lake basin are the remnant splash dams on Marble creek in the St. Joe watershed.

Improperly placed or poorly maintained culverts can be barriers to fish movement. These culverts tend to negatively impact native trout by limiting distribution or preventing access to high quality spawning and rearing areas. Where culverts prevent invasion of exotic fishes, they may have a positive effect on native trout populations. Barriers should be evaluated for their effect to native fishes and amphibians in the drainage before they are placed or removed. Migration barriers created by culverts are common in the Coeur d'Alene Lake basin.

3.1.3 HYBRIDIZATION, COMPETITION, AND PREDATION

Chinook salmon feed on kokanee salmon (both introduced species) in Coeur d'Alene Lake. Kokanee are likely an important forage item for adfluvial native trout. Kokanee are relatively abundant in the lake, and it is unknown whether there is enough predation on kokanee by chinook to result in competition with native trout. Chinook salmon likely feed on westslope cutthroat trout as well.

Northern pike are found throughout the Coeur d'Alene basin and are known to consume large numbers of migratory cutthroat trout, but it is unknown how much of a threat they pose for other native trout species migrating into the lake. Northern pike have been in the Coeur d'Alene system since at least the 1970's. Native northern pike-minnows (formerly known as northern squawfish) also prey on juvenile trout migrants in the lower St. Joe and Coeur d'Alene River and Coeur d'Alene Lake.

3.1.4 HARVEST AND FISHING MORTALITY

Impacts to native trout may result from activities or management actions that are legal according to present laws and regulations. Ongoing fishery management activities that may threaten native trout include a limited harvest fishery on westslope cutthroat trout in the St. Joe and Coeur d'Alene Rivers and Coeur d'Alene Lake as well as maintaining year around fishing seasons for exotic chinook salmon in the lake which can result in incidental catch. Even in cases where an angler releases the fish, incidental mortality of 4% has been documented (Schill and Scarpella 1997). Spawning native trout are particularly vulnerable to illegal harvest since the fish are easily observed in the small tributaries located on the Reservation. Historically, broodstock collection, another form of harvest, also impacted native fish populations. In particular, successive year broodstock collection by Idaho Fish and Game of westslope cutthroat trout in Evans Creek, a tributary to the Coeur d'Alene River, eliminated the adfluvial life history form from that watershed.

3.2 WESTSLOPE CUTTHROAT TROUT

Range wide causes of decline include competition with and predation by non-native species, genetic introgression, overfishing, habitat loss and fragmentation, and habitat degradation (Liknes 1984; Liknes and

Graham 1988; Rieman and Apperson 1989; McIntyre and Rieman 1995). In Idaho, habitat loss was identified as the primary cause of decline in streams supporting depressed populations (Rieman and Apperson 1989). Peters et. al. (1999) determined that due to the persistence of adverse conditions in natal streams and Coeur d'Alene Lake, cutthroat trout populations are thought to be at least moderately damaged (i.e. average spawning escapements fall between the minimum viable population and the number of adults needed to produce 50% of the carrying capacity of the stream environment) for the following reasons:

- Stochastic events that result in increased mortality of embryo, fry, and juvenile lifestages (e.g. peak and extreme low flow events) have been exacerbated by land use practices during the last 60 years;
- Competition for limited space and food during base flow conditions cause displacement of juveniles into water quality limited stream reaches;
- Competitive interactions with introduced salmonids may result in replacement of native trout in Alder Creek and Benewah Creek;
- Water temperatures in the upper ten meters of the water column in Coeur d'Alene Lake exceed the optimum as described in the HSI for cutthroat trout;
- Sediment loading from tributaries in combination with large quantities of aquatic macrophyte growth and low dissolved oxygen concentrations in the hypolimnion promote conditions more favorable for introduced fish species in Coeur d'Alene Lake; and
- Competitive interactions with introduced species for food, living space, and through predation limit cutthroat trout in both the littoral and limnetic zones of Coeur d'Alene Lake.

Peak flows in Lake Creek and Benewah Creek have been identified in previous reports as a potential limiting factor for trout production (Lillengreen 1996). Generally, increased flows during egg incubation will be favorable until they reach the point when scouring and other flood damage may take place (Allen 1969). Spikes in stream discharge during the early spring, as is characteristic of the Lake Creek and Benewah Creek watersheds, may cause redd scouring and egg damage, although no attempt has been made to quantify this source of mortality. For example, stream flows in upper Lake Creek during spring of 1997 exceeded the sheer stress of spawning gravels (5 cm geometric mean particle diameter) for 4 consecutive days during the incubation period. It is conceivable that flow events of this magnitude could scour trout redds and result in complete year class failures. Although flood damage is a natural source of mortality, canopy reduction in each of the target watersheds has probably contributed to higher storm runoff peaks. Scouring of trout redds is certainly a more frequent occurrence than in the recent past.

Typical base flow conditions in the target watersheds force juvenile trout into small pools where competition for limited space and food may occur. Other authors have suggested that at high densities, competition for space among juveniles may lead to dispersal, downstream displacement or mortality in salmonids (Chapman 1962; Mason and Chapman 1965; Everest 1971; Erman and Leidy 1975; LeCren 1973). In water quality limited systems, such as Lake Creek, Benewah Creek, and Alder Creek, dispersal to downstream areas exposes juvenile cutthroat to suboptimal temperature conditions that increase stress, weaken individuals and may result in mortality.

Westslope cutthroat trout hybridize with rainbow trout producing inferior progeny that can significantly alter the genetic composition of the entire population. Westslope cutthroat trout are also negatively impacted by brook trout. Cutthroat trout did not evolve with brook trout in the Coeur d'Alene subbasin. Therefore, mechanisms that promote coexistence and resource partitioning have likely not developed. Griffith (1972) demonstrated that cutthroat trout fry emerge from the gravel later in the year than brook trout and, thus, age-0 cutthroat trout acquire a statistically significant length disadvantage that may continue throughout their lifetime. Such a size discrepancy may enhance resource partitioning, but in times of habitat shortage cutthroat trout may be at a disadvantage if they cannot hold territories against larger competitors. Competitive exclusion is a likely cause of decline for cutthroat trout in some subbasin watersheds. Replacement of this kind, at least in stream environments, may be an irreversible process (Moyle and Vondracek 1985). This was found to be the case in Yellowstone National Park, where the introduction of brook trout has nearly always resulted in the disappearance of the cutthroat trout

(Varley and Gresswell 1988). Implications are that cutthroat trout may have a difficult time naturally recovering given continued water quality degradation and the persistence of brook trout.

Based on the water quality HSI's (Hickman and Raleigh 1982) calculated for cutthroat trout, the upper 10 meters of the water column in Coeur d'Alene Lake generally is not suitable habitat. At only one of thirteen sample locations was the HSI value higher than 0.0. This does not mean that cutthroat trout will not be found there, but they will have trouble sustaining themselves over a long period of time. Furthermore, the euphotic zone rarely drops below 10 meters in Coeur d'Alene Lake so any foraging runs into that zone will take them into unsuitable habitat, which results in added stress. Thus, all areas represented by sample stations less than ten meters in depth would be considered unsuitable cutthroat trout habitat with deeper stations showing limited distribution during certain times of the year.

Increased loading of sediments from agricultural runoff does affect cutthroat suitability, though not directly, in areas near the mouths of streams in and around the lake. Sediment is accumulating at the mouth of Plummer creek in Chatcolet Lake at a rate of 2.4 cm/year (Breithaupt, 1990). This, in turn, increases the surface area where large masses of aquatic macrophytes can grow. These masses of aquatic plants can impair juvenile and adult migrations and serve as the primary foraging areas for larger piscivorous fishes.

Low quantities of dissolved oxygen did occur at some of the sample sites, however, it is not considered limiting for cutthroat trout suitability. Low dissolved oxygen, however, is thought to have indirect affects on cutthroat trout suitability in the southern lakes area. Low dissolved oxygen values most likely are occurring from decomposition of organic matter from allochthonous sources as well as from aquatic macrophytes. Reiman (1980) and Woods (1989) noted hypolimnetic oxygen deficits in Coeur d'Alene Lake in 1979 and 1987 as well.

Of the introduced species the following have been shown to have the ability to actively feed on other fish species including adult and juvenile cutthroat trout: northern pike, largemouth bass, smallmouth bass, chinook salmon, and channel catfish. Historically, bull trout and northern squawfish were the only predators of cutthroat trout in the lake. Electrofishing data shows that these predators are associated primarily with the shoreline littoral zone. The relative abundance data shows that five species of piscivorous fishes (four introduced) have relative abundances higher than cutthroat trout. This would indicate that cutthroat trout are probably being competitively excluded from this littoral zone habitat by these other fishes.

Historically, cutthroat trout in Coeur d'Alene Lake probably utilized the littoral zone of the lake until they were large enough to move offshore and feed, most likely, on mid water prey and fish when available. Nilsson and Northcote (1981) noted that cutthroat trout in allopatry with other salmonids were found throughout the lake and in sympatry, they were located primarily in the littoral zone. It has been shown that introduction of kokanee salmon will also have detrimental effects on the cutthroat trout population (Gerstung, 1988; Marnell, 1988). Marnell (1988) determined that declines in westslope cutthroat trout populations in lakes in Glacier National Park where kokanee were introduced were caused by competition for planktivorous food. Thus, the introduction of non-native species into Coeur d'Alene Lake, at the minimum, altered the normal behavioral pattern of the cutthroat trout in both the littoral and limnetic zones of Coeur d'Alene Lake.

Restoration efforts rectifying many of the habitat concerns will continue to be conducted in each of the target watersheds. However, given the various physical and environmental constraints limiting production it is doubtful that habitat restoration in itself will result in substantial increases in the production of cutthroat trout in the near future. There is little information specific to the target watersheds that can be used to estimate its potential production capacity for cutthroat trout. Based on available data it can be assumed that production is relatively low when compared to other North Idaho cutthroat trout bearing streams. Although habitat restoration work and better resource management will result in improved survival rates for cutthroat trout it is believed that any significant increase in the total run size will require hatchery supplementation.

3.3 GENETIC RISK ASSESSMENT

See Appendix (C) for the complete genetic risk assessment. Samples were obtained from 16 sites by the Coeur d'Alene Tribe (Table 3.3.1). This section summarizes contracted work completed for the Tribe at the Wild Trout and Salmon Genetics Lab at the University of Montana.

Fin clips were stored in 95% ethanol and transported to the Wild Trout and Salmon Genetics Lab at the University of Montana for analysis. Two tests were performed. The first test used PINEs to detect the presence and/ or level of hybridization in the samples from the 16 locations. Six sites contained samples of westslope cutthroat trout with no evidence of hybridization. The remaining ten sites included at least one hybrid individual. Three of these locations contained a single hybrid individual. When present in the sample locations, hybridization occurs at a low level and most likely represents episodic events of migration into these systems by rainbow trout or hybrid individuals. The maximum number of hybrid individuals (28%) found was in Cherry Creek. That sample also had the highest level of hybridization. On average, hybrid individuals contained 37.5% of the rainbow trout markers. However, these same individuals also contained 100% of the markers diagnostic for westslope cutthroat. If this population had experienced high levels of hybridization for an extended period of time, we would expect to see the loss of westslope markers. Thus, even in Cherry Creek it appears as though hybridization events occur episodically not continually.

Table 3.3.1 Sample sites and sizes, collection dates and possible life history forms for westslope cutthroat trout captured in the Coeur d'Alene Lake basin by the Coeur d'Alene Tribe in 1998. Except as noted only juvenile fish were collected.

Location*	Life History**	Collection Dates	Sample Size
Fighting Creek	Resident?	12 June, 1998	29
Cherry Creek	Resident?/Adfluvial?	18 June, 1998	29
Hells Gulch Creek	Resident?	11 June, 1998	29
Alder Creek	Resident	30 July, 1998	6
Evans Creek	Resident	29 July, 1998	33
South Fork Evans Creek	Resident	29 July, 1998	27
Benewah Creek 1	Adfluvial	April, 1998	24 (18 juvenile, 6 adult)
Benewah Creek 2	Adfluvial?	April, 1998	10 (adults)
South East Fork Benewah Creek	Resident?/Adfluvial?	26 June, 1998	22
Whitetail Creek	Resident?/Adfluvial?	30 June, 1998	17
Windfall Creek	Resident?/Adfluvial?	01 July, 1998	35
Bull Creek	Resident?/Adfluvial?	02 July, 1998	30
Lake Creek 1	Adfluvial	March-April, 1998	48 (41 juvenile, 7 adult)
Lake Creek 2	Resident?/Adfluvial?	04 August, 1998	18
Bozard Creek	Resident?/Adfluvial?	05 August, 1998	27
West Fork Lake Creek	Resident?/Adfluvial?	04 August, 1998	32
Totals			**416**

* Sample locations are identified on the enclosed map.

The second test used seven microsatellite loci to determine the genetic relationships among westslope cutthroat trout collected from 16 sample locations. These sample locations have statistically significant differences in allele frequencies at one or two loci. However, the overall genetic distances as estimated using two techniques are quite small. These results are consistent with a system in which gene flow occurs but not at a sufficient rate to make these populations genetically homogeneous. The differences in allele frequencies are probably the result of genetic drift in small populations. All seven microsatellite loci analyzed were polymorphic in Coeur d' Alene Lake westslope cutthroat trout. Allelic distributions, estimators of pair-wise divergence, and significance measures indicate little correlation between geographic distance and genetic differentiation. Based on this overall lack of geographical structuring, an island model of migration (see pp. 192-194 in Hartl and Clark 1997 for review) does not seem unreasonable for these populations. Assuming an island model and an F_{ST} of 0.038, the estimated rate of gene flow among populations is approximately seven individuals per generation (Allendorf & Phelps 1981). The level of genetic differentiation estimated in Coeur d' Alene cutthroat trout by microsatellites appears to be considerably less than estimates from other areas obtained using allozymes. For example, across the range of the species, the estimated F_{ST} is 0.333 (R. F. Leary, pers. comm.). Within the South Fork of the Flathead River, F_{ST} was estimated to be 0.150 (R. F. Leary, pers. comm.). Both of these values were based on allozymes in which genetic distinction should arise more slowly. Thus, the microsatellite-based F_{ST} estimates presented in this report appear to be quite low for westslope cutthroat trout. However, levels of heterozygosity appear to be reasonably high, minimizing the possibility that inbreeding depression is currently a problem.

Samples of westslope cutthroat from Coeur d' Alene Lake tributaries differ significantly in allele frequencies but have low estimated values of genetic distance. This may appear to be a contradiction. However, differentiation may occur even with some level of gene flow. One migrant per generation is sufficient to prevent the loss of rare alleles. More migrants are necessary to produce a genetically homogeneous population. If the migration rate is below this threshold, genetic drift will alter allele frequencies at random loci. This appears to be the case in these samples.

In the case of Coeur d' Alene Lake westslope cutthroat trout, sample sites appear genetically quite similar. Thus, risk that local adaptations will be eliminated due to outbreeding depression is lessened. However, given the complex life history of migratory fish in this system, some concern must remain. We cannot be certain that migratory forms from one area will thrive in another. Assuming only one brood stock will be created, the best alternative is probably to collect fish from multiple source populations and use this mixture as the brood stock.

The greatest genetic risks of a properly managed hatchery in this system are domestication of the brood stock and inadvertent introgression with rainbow trout. We have characterized many of the tributaries that might serve as brood stock. Therefore, managers can avoid using individuals from hybridized populations. However, some routine genetic monitoring should be initiated to identify and eliminate any hybrid individuals that may be included in the brood stock. The brood stocks should also be maintained in a manner to maximize the number of breeders in order to avoid inbreeding depression and minimize domestication.

The long-term solution to the decline of westslope cutthroat trout in Coeur d' Alene Lake is to identify and correct the causes of the decline. In many cases, these causes are probably related to habitat degradation. If habitat rehabilitation will take longer than westslope cutthroat trout will persist in these tributaries, more intensive short-term management, such as hatchery supplementation could be considered.

Given this information selecting a single group of broodstock from each of the target tributaries will avoid some of the genetic problems associated with loss of gene diversity between populations, as well as, reduce the risk of outbreeding depression.

3.4 NATIVE FISH INTERACTION

One of the main goals of our restoration and supplementation program will be to maintain the genetic integrity of the wild populations as well as, increase the numbers of fish reproducing in the natural environment. The purpose of the supplementation program is to restore the naturally reproducing populations to historic levels commensurate with the carrying capacity of the natural habitat. Thus, the adverse effects of predation, competition for food and living space, and disease should be no more than what was experienced by the population when at historic abundance levels. The supplementation program proposed seeks to minimize or eliminate any differences between the stocked and wild fishes so that they are a single population. Hatchery releases will be proportional to natural production so that the carrying capacity of the stream is not surpassed.

4.0 COEUR D'ALENE RESERVATION TARGET TRIBUTARY CARRYING CAPACITY

The carrying capacity of the target tributaries was predicted by inputting measured habitat and water quality parameters into a Habitat Quality Index (HQI) model which was developed to predict trout standing crop in Wyoming streams (Binns and Eiserman 1979). The HQI Model II was originally used to predict trout biomass in Wyoming streams using eleven attributes: late-summer stream flow, annual stream flow variation, maximum summer water temperature, nitrate nitrogen, fish food abundance, fish food diversity, instream cover, eroding streambanks, submerged aquatic vegetation, water velocity, and stream width. The model explained 96% of the variation in trout biomass for the 36 streams from which it was developed, and 87% of the variation for 16 Wyoming streams examined in a follow-up study by Conder and Annear (1987).

Griffith (1993) reported that attempts to apply the HQI to populations of salmonids in streams outside of Wyoming have generally not been successful, citing that trout populations in different areas respond to different sets of factors. Binns and Eiserman (1979) acknowledged such weaknesses in the original model, indicating that anomalies in trout population densities caused by extremes in climatic conditions or by anthropogenic influence could cause variability in HQI predictions. They suggested that specific understanding of the life history requirements of target species would justify modifications of model variables to provide more accurate evaluations of local habitat conditions.

We felt that modifications of the attribute for maximum summer water temperature were needed to reflect the specific tolerances of westslope cutthroat trout. The original model was applied to streams that supported multiple salmonid species (including brook, brown, rainbow, and cutthroat trout) and used temperature ranges that were, in some cases, higher than the upper incipient lethal temperature reported for cutthroat trout (Behnke 1979; Behnke and Zarn 1976; Bell 1973). We modified the temperature rating characteristics of the model by using values that corresponded to 20-100% suitability on the suitability index graph published by Hickman and Raleigh (1982). In addition, we changed the lower rating characteristic for the late summer stream flow attribute to reflect the fact that tributaries on the Reservation support juvenile trout to a much greater extent than resident adults. Therefore, in our model late summer stream flows ≥8% of average annual stream flow provide at least sporadic but limited support for juvenile rearing. Data published by Hickman and Raleigh (1982) indicating 100% suitability for juvenile cutthroat residing in small streams when the average thalweg depth reaches 30 cm, seem to support this assumption.

4.1 JUVENILE REARING

When HQI scores ($\hat{Y}$) were plotted against the three-year mean of measured trout standing crop (Y), the scatter of data points was best fitted by the linear equation $Y = 1.779 + 0.911(\hat{Y})$ (Figure 4.1.1). The model explained 83% of the variation in trout standing crop for 8 tributaries that were tested, and a high correlation coefficient ($R = 0.915$) suggested a strong relationship between HQI score and trout standing crop (Table 4.1.1). For two tributaries (Evans Creek and SE Benewah Creek), there was considerable deviation between measured and predicted values. In Evans Creek, a history of human intervention probably explains the difference between these values. Evans Creek served as a source of brood stock for state sponsored stocking programs, and adfluvial adults were captured and removed throughout the 1970's and early 1980's (personal communication, IDFG). We believe this resulted in complete failure of multiple year classes, and compensatory survival (a result of decreased competition and increased growth in response to favorable conditions) has not yet resulted in reseeding of available habitats. Reasons for the discrepancy between measured and predicted values in SE Benewah are unknown, but are thought to be reflective of underseeded spawning habitat. Given the results of model predictions and in consideration of mitigating factors, we believe the HQI Model II is a reasonable predictor of cutthroat trout standing crop for Reservation streams and can be used as an indicator of juvenile carrying capacity.

Figure 4.1.1 Relationship between HQI score and trout standing crop (kg/hectare) at 8 tributaries evaluated with HQI Model II.

The tested model was used predict changes in carrying capacity given several projections of expected improvements in habitat quality resulting from ongoing restoration efforts (Table 9.1.2). The projections correspond to 25%, 50%, 75% and 100% improvement targets as adopted into the 1995 Columbia River Basin Fish and Wildlife Program (10.8B.20). Realistic dates for these respective levels of habitat improvement have been designated as 2007, 2012, 2016 and beyond. The habitat attributes that are thought to be most responsive to restoration techniques during these timeframes, and which have been manipulated during iterations of model predictions, include late summer stream flow, eroding streambanks, instream cover, fish food abundance and maximum summer water temperature. Late summer stream flow was only manipulated in the final iteration (beyond category) of the model.

The 2007 prediction of carrying capacity constitutes a 2.4% increase in the total number of juveniles compared with current values (Table 4.1.3). This prediction was arrived at by improving the instream cover and eroding streambank attributes by a 5% increment in all tributaries that did not receive the highest attribute rating. All other attributes were left unchanged. The 2012 prediction constitutes a 34.7% increase in the total number of juveniles compared with 1998 values (Table 4.1.3). This prediction was arrived at by improving the instream cover and eroding streambank attributes by an additional 5% increment in all tributaries that did not receive the highest attribute rating. In addition, maximum summer water temperature was decreased by 1°C in all tributaries that exceeded 17°C. The 2016 prediction constitutes a 117.1% increase in the total number of juveniles compared with 1998 values (Table 4.1.3). This prediction was arrived at by improving the instream cover and eroding streambank attributes by an

Table 4.1.3.

Carrying capacity predictions for juvenile cutthroat trout in tributaries of the Coeur d'Alene Reservation.

	Standing Crop (kg/hectare)					Number of Juveniles				
Tributary	**1998**	**2007**	**2012**	**2016**	**Beyond**	**1998**	**2007**	**2012**	**2016**	**Beyond**
Lake Creek (Lower)	8	9	24	27	88	1036	1165	3108	3496	11396
Lake Creek (Upper)	49	49	68	108	150	7322	7322	10161	16138	22414
Evans Creek	122	122	158	250	250	18129	18129	23478	37149	37149
N.F. Alder Creek	30	33	45	83	184	1132	1245	1698	3333	7390
Alder Creek	25	28	37	37	95	4211	4716	6232	9510	24418
Benewah Creek (mainstem)	14	14	14	39	55	4577	4577	4577	13313	18775
S.E. Fork Benewah	95	100	130	130	180	2401	2527	3285	3655	5060
West Fork Benewah	76	80	80	80	111	1200	1263	1263	964	1337
Whitetail Creek	19	19	25	43	76	461	461	607	863	1526
Windfall Creek	20	22	30	51	90	828	910	1241	1229	2169
Totals	458	476	611	848	1279	41295	42316	55650	89650	131633

additional 5% increment in all tributaries that did not receive the highest attribute rating. In addition, maximum summer water temperature was decreased by 1°C in all tributaries that exceeded 16.8°C.

The prediction for the "beyond" category is a best professional judgement that approximates the desired future condition for Reservation tributaries (Table 4.1.4). Desired future condition is defined as being equivalent to the potential natural community. In other words, biological productivity and diversity at the landscape level is equivalent to the site potential. This concept can be described as a situation where natural aquatic ecosystem functions are similar to those in which the landscape developed and its component parts evolved, but with the recognition that a number of human-caused factors will preclude a complete return to the historical condition. However, under this scenario ecological processes (succession, natural disturbances, competition, evolution, etc.) and hydrological processes (sediment transport and deposition, flood plain storage and subsurface recharge, nutrient cycling, etc.) function in such a manner as to ensure a sustainable intact ecosystem. This prediction constitutes a 218.7% increase in the number of juveniles compared with 1998 values (Table 4.1.3).

Table 4.1.1.

Habitat Quality Index attribute measurement data, ratings and calculations for tributaries of the Coeur d'Alene Reservation, based on current conditions (1998).

Attribute	Model symbol	Lake Creek below Elder Rd. Data	Rating	Lake Creek upper Data	Rating	Evans Creek Data	Rating	N.F. Alder Creek Data	Rating	Alder Creek Data	Rating	Benewah Creek below 9mile Data	Rating	S.E. Benewah Data	Rating	W.F. Benewah Data	Rating	Whitetail Data	Rating	Windfall Data	Rating
Late summer stream flow	X1	CPF=6%ADF	0	CPF=10%ADF	1	CPF=16%ADF	2	CPF=6%ADF	1	CPF=6%ADF	1	CPF=10% ADF	1	CPF=10%ADF	1	CPF=5%ADF	1	CPF=4%ADF	0	CPF=7%ADF	0
Annual stream flow variation	X2		2		2		3		2		2		2		2		1		1		1
Maximum summer water temperature (°C)	X3	22.6	1	18.0	3	17.1	3	20.1	2	21.4	2	23.1	1	16.8	4	16.2	4	18.6	3	24.3	3
Nitrate nitrogen (mg/l)	X4	0.10	3	0.05	2	0.10	3	0.05	2	0.05	2	0.12	3	0.06	2	0.30	3	0.05	2	0.05	2
Fish food abundance (numbers/0.1 m2)	X5	534	4	129	2	535	4	530	4	437	3	499	3	594	4	594	4	594	4	594	4
Fish food diversity	X6	2.41	3	2.41	3	2.35	3	2.29	3	2.29	3	2.25	3	2.25	3	2.25	3	2.25	3	2.25	3
Cover (%)	X7	40	2	35	2	57	4	48	3	25	1	28	2	51	3	54	3	30	2	40	2
Eroding banks (%)	X8	22	3	7	4	8	4	25	2	40	2	45	2	8	4	7	4	9	4	15	3
Substrate	X9		3		3		2		3		3		3		3		3		3		3
Water velocity	X10		2		2		2		2		2		2		2		2		2		2
Stream width (m)	X11	3.6	3	1.5	1	3.6	3	3.7	3	3.6	3	5.0	3	2.7	2	1.6	1	2.0	1	2.1	2
Calculation of trout standing crop																					
X1 + 1			1		2		3		2		2		2		2		2		1		1
X2 + 1			3		3		4		3		3		3		3		2		2		2
X3 + 1			2		4		4		3		3		2		5		5		4		4
P + 1			1296		192		3456		864		216		648		1152		864		384		576
F + 1			18		36		36		24		24		18		48		72		36		36
S + 1			18		8		48		18		6		12		24		12		8		12
Model I - Predicted standing crop (kg/hectare)			10		33		194		34		22		17		79		37		10		11
Model II - Predicted standing crop (kg/hectare)			**8**		**49**		**122**		**38**		**25**		**14**		**95**		**76**		**19**		**20**
Measured standing crop (kg/hectare)																					
1996			6		21		18		34		26		8		26		37		51		23
1997			7		48		24		20		14		2		19		94		13		33
1998			11		36		14		34		26		1		33		98		9		51
Mean			**8**		**35**		**18**		**29**		**22**		**4**		**26**		**76**		**24**		**36**

Habitat Quality Index attribute measurement data, ratings and calculations for tributaries of the Coeur d'Alene Reservation, based on 25% expected improvements in habitat quality from restoration efforts (2007).

Attribute	Model symbol	Lake Creek below Elder Rd Data	Rating	Lake Creek upper Data	Rating	Evans Creek Data	Rating	N.F. Alder Creek Data	Rating	Alder Creek Data	Rating	Benewah Creek below 9 mile Data	Rating	S.E. Benewah Data	Rating	W.F. Benewah Data	Rating	Whitetail Data	Rating	Windfall Data	Rating
Late summer stream flow	X1	CPF=8%ADF	0	CPF=12%ADF	1	CPF=16%ADF	2	CPF=8%ADF	1	CPF=6%ADF	1	CPF=10% ADF	1	CPF=10%ADF	1	CPF=9%ADF	1	CPF=4%ADF	0	CPF=7%ADF	0
Annual stream flow variation	X2		2		2		3		2		2		2		2		1		1		1
Maximum summer water temperature (°C)	X3	22.6	1	18.8	3	17.1	3	20.1	2	21.4	2	23.1	1	16.8	4	16.2	4	18.6	3	18.6	3
Nitrate nitrogen (mg/l)	X4	0.10	3	0.05	2	0.10	3	0.05	2	0.05	2	0.12	3	0.06	2	0.38	3	0.06	2	0.05	2
Fish food abundance (number/0.1 m2)	X5	534	4	129	2	535	4	530	4	437	3	499	3	584	4	584	4	584	4	584	4
Fish food diversity	X6	2.41	3	2.41	3	2.36	3	2.29	3	2.29	3	2.25	3	2.25	3	2.25	3	2.25	3	2.25	3
Cover (%)	X7	45	3	48	2	57	4	53	3	38	2	33	2	56	4	58	4	36	2	45	3
Eroding banks (%)	X8	17	3	7	4	8	4	20	3	35	2	40	2	8	4	7	4	9	4	10	3
Substrate	X9		3		3		2		3		3		3		3		3		3		3
Water velocity	X10		2		2		2		2		2		2		2		2		2		2
Stream width (m)	X11	3.6	3	1.5	1	3.6	3	3.7	3	3.6	3	5.0	3	2.7	2	1.6	1	2.0	1	2.1	2
Calculation of trout standing crop																					
X1 + 1			1		2		3		2		2		2		2		2		1		1
X2 + 1			3		3		4		3		3		3		3		2		2		2
X3 + 1			2		4		4		3		3		2		5		5		4		4
P + 1			1944		192		3456		1296		432		648		1536		1152		384		864
F + 1			18		36		36		24		24		18		48		72		36		36
S + 1			27		8		48		27		12		12		32		16		8		18
Model II - Predicted standing crop (kg/hectare)			**9**		**49**		**122**		**33**		**28**		**14**		**100**		**80**		**18**		**22**

Habitat Quality Index attribute measurement data, ratings and calculations for tributaries of the Coeur d'Alene Reservation, based on 50% expected improvements in habitat quality from restoration efforts (2012).

Attribute	Model symbol	Lake Creek below Elder Rd Data	Rating	Lake Creek upper Data	Rating	Evans Creek Data	Rating	N.F. Alder Creek Data	Rating	Alder Creek Data	Rating	Benewah Creek below 9 mile Data	Rating	S.E. Benewah Data	Rating	W.F. Benewah Data	Rating	Whitetail Data	Rating	Windfall Data	Rating
Late summer stream flow	X1	CPF=8%ADF	0	CPF=12%ADF	1	CPF=16%ADF	2	CPF=8%ADF	1	CPF=6%ADF	1	CPF=10% ADF	1	CPF=10%ADF	1	CPF=9%ADF	1	CPF=4%ADF	0	CPF=7%ADF	0
Annual stream flow variation	X2		2		2		3		2		2		2		2		1		1		1
Maximum summer water temperature (°C)	X3	21.5	2	17.8	3	17.1	3	19.1	2	20.4	2	22.1	1	16.8	4	16.2	4	17.6	3	17.6	3
Nitrate nitrogen (mg/l)	X4	0.10	3	0.10	3	0.10	3	0.10	3	0.10	3	0.12	3	0.10	3	0.38	3	0.10	3	0.10	3
Fish food abundance (number/0.1 m2)	X5	534	4	268	3	535	4	530	4	437	3	499	3	584	4	584	4	584	4	584	4
Fish food diversity	X6	2.41	3	2.41	3	2.36	3	2.29	3	2.29	3	2.25	3	2.25	3	2.25	3	2.25	3	2.25	3
Cover (%)	X7	50	3	45	3	57	4	58	4	35	2	38	2	56	4	58	4	40	2	50	3
Eroding banks (%)	X8	12	3	7	4	8	4	15	3	30	2	36	2	8	4	7	4	9	4	9	4
Substrate	X9		3		3		3		3		3		3		3		3		3		3
Water velocity	X10		2		2		2		2		2		2		2		2		2		2
Stream width (m)	X11	3.6	3	1.5	1	3.6	3	3.7	3	3.6	3	5.0	3	2.7	2	1.6	1	2.0	1	2.1	2
Calculation of trout standing crop																					
X1 + 1			1		2		3		2		2		2		2		2		1		1
X2 + 1			3		3		4		3		3		3		3		2		2		2
X3 + 1			3		4		4		3		3		2		5		5		4		4
P + 1			1944		640		3456		2592		640		648		2304		1152		576		1728
F + 1			36		54		54		36		36		18		72		72		54		54
S + 1			27		12		48		36		12		12		32		16		8		24
Model II - Predicted standing crop (kg/hectare)			**26**		**68**		**158**		**45**		**37**		**14**		**130**		**80**		**25**		**38**

Habitat Quality Index attribute measurement data, ratings and calculations for tributaries of the Coeur d'Alene Reservation, based on 75% expected improvements in habitat quality from restoration efforts (2016).

Attribute	Model symbol	Lake Creek below Elder Rd Data	Rating	Lake Creek upper Data	Rating	Evans Creek Data	Rating	N.F. Alder Creek Data	Rating	Alder Creek Data	Rating	Benewah Creek below 9 mile Data	Rating	S.E. Benewah Data	Rating	W.F. Benewah Data	Rating	Whitetail Data	Rating	Windfall Data	Rating
Late summer stream flow	X1	CPF=8%ADF	0	CPF=12%ADF	1	CPF=16%ADF	2	CPF=8%ADF	1	CPF=6%ADF	1	CPF=10% ADF	1	CPF=10%ADF	1	CPF=9%ADF	1	CPF=4%ADF	0	CPF=7%ADF	0
Annual stream flow variation	X2		2		2		3		2		2		2		2		1		1		1
Maximum summer water temperature (°C)	X3	20.5	2	16.8	4	16.1	4	19.1	3	19.4	2	21.1	2	16.8	4	16.2	4	16.6	4	16.6	4
Nitrate nitrogen (mg/l)	X4	0.10	3	0.10	3	0.10	3	0.10	3	0.10	3	0.12	3	0.10	3	0.38	3	0.10	3	0.10	3
Fish food abundance (number/0.1 m2)	X5	534	4	508	4	535	4	530	4	508	4	525	4	584	4	584	4	584	4	584	4
Fish food diversity	X6	2.41	3	2.41	3	2.36	3	2.29	3	2.29	3	2.25	3	2.25	3	2.25	3	2.25	3	2.25	3
Cover (%)	X7	55	4	50	3	57	4	58	4	40	2	43	3	56	4	58	4	45	3	55	4
Eroding banks (%)	X8	9	4	7	4	8	4	10	3	25	2	30	2	8	4	7	4	9	4	9	4
Substrate	X9		3		3		3		3		3		3		3		3		3		3
Water velocity	X10		2		2		2		2		2		2		2		2		2		2
Stream width (m)	X11	3.6	3	1.5	1	3.6	3	3.7	3	3.6	3	5.0	3	2.7	2	1.6	1	2.0	1	2.1	2
Calculation of trout standing crop																					
X1 + 1			1		2		3		2		2		2		2		2		1		1
X2 + 1			3		3		4		3		3		3		3		2		2		2
X3 + 1			3		5		5		4		3		3		5		5		5		5
P + 1			3456		864		3456		2592		864		1296		2304		1152		864		2304
F + 1			36		72		72		54		36		36		72		72		72		72
S + 1			48		12		48		36		12		18		32		16		12		32
Model II - Predicted standing crop (kg/hectare)			**37**		**188**		**258**		**83**		**37**		**39**		**130**		**80**		**43**		**56**

Table 4.1.1 cont.

Habitat Quality Index attribute measurement data, ratings and calculations for tributaries of the Coeur d'Alene Reservation, based on optimal future desired condition beyond 2016.

Attribute	Model symbol	Lake Creek below Elder Rd. Data	Rating	Lake Creek upper Data	Rating	Evans Creek Data	Rating	W.F. Alder Creek Data	Rating	Alder Creek Data	Rating
Late summer stream flow	X1	CPF=10%ADF	1	CPF=10%ADF	2	CPF=10%ADF	2	CPF=10%ADF	2	CPF=10%ADF	2
Annual stream flow variation	X2		2		2		3		2		2
Maximum summer water temperature (°C)	X3	18.0	3	16.0	4	16.1	4	16.1	4	17.4	3
Nitrate nitrogen (mg/l)	X4	0.10	3	0.10	3	0.10	3	0.10	3	0.10	3
Fish food abundance (number/0.1 m2)	X5	534	4	500	4	535	4	530	4	500	4
Fish food diversity	X6	2.41	3	2.41	3	2.35	3	2.29	3	2.29	3
Cover (%)	X7	55	4	50	3	67	4	58	4	40	2
Eroding banks (%)	X8	9	4	7	4	8	4	10	3	25	2
Substrate	X9		3		3		3		3		3
Water velocity	X10		2		2		2		2		2
Stream width (m)	X11	3.6	3	1.6	1	3.6	3	3.7	3	3.6	3
Calculation of trout standing crop											
X1 + 1			2		3		3		3		3
X2 + 1			3		3		4		3		3
X3 + 1			4		5		5		5		4
P + 1			3456		864		3456		2592		864
F + 1			54		72		72		72		54
S + 1			48		12		48		36		12
Model II - Predicted standing crop (kg/hectare)			**88**		**150**		**250**		**184**		**95**

Attribute	Model symbol	Benewah Creek below 9mile Data	Rating	S.E. Benewah Data	Rating	W.F. Benewah Data	Rating	Whitetail Data	Rating	Windfall Data	Rating
Late summer stream flow	X1	CPF=10% ADF	2	CPF=10%ADF	2	CPF=10%ADF	2	CPF=8%ADF	1	CPF=10%ADF	1
Annual stream flow variation	X2		2		2		1		1		1
Maximum summer water temperature (°C)	X3	19.1	2	16.8	4	16.2	4	16.6	4	16.6	4
Nitrate nitrogen (mg/l)	X4	0.12	3	0.10	3	0.30	3	0.10	3	0.10	3
Fish food abundance (number/0.1 m2)	X5	525	4	594	4	594	4	594	4	594	4
Fish food diversity	X6	2.25	3	2.25	3	2.25	3	2.25	3	2.25	3
Cover (%)	X7	43	3	61	4	64	4	45	3	65	4
Eroding banks (%)	X8	30	2	8	4	7	4	9	4	5	4
Substrate	X9		3		3		3		3		3
Water velocity	X10		2		2		2		2		2
Stream width (m)	X11	5.0	3	2.7	2	1.6	1	2.0	1	2.1	2
Calculation of trout standing crop											
X1 + 1			3		3		3		2		2
X2 + 1			3		3		2		2		2
X3 + 1			3		5		5		5		5
P + 1			1296		2304		1152		864		2304
F + 1			36		72		72		72		72
S + 1			18		32		16		12		32
Model II - Predicted standing crop (kg/hectare)			**55**		**188**		**111**		**76**		**98**

4.2 COEUR D'ALENE RESERVATION TRIBUTARIES ADULT SPAWNING AND HARVEST OBJECTIVES

Biological objectives for wild adfluvial cutthroat trout in tributaries of the Coeur d'Alene Reservation include rebuilding adult populations to 75-100 percent of the optimum level. This will be accomplished by achieving interim biological objectives (25 percent and 50 percent of optimum level) by the dates noted in the following table 4.2.1.

Table 4.2.1 Biological and harvest objectives for wild adfluvial cutthroat trout in tributaries of the Coeur d'Alene Reservation

Tributary	Target Level[a] (percent)	Escapement[b] Target	Harvest Target[c]	Biological[d] Objective	Year
Alder Creek	25	1,708	920	2,628	2007
	50	3,416	1,840	5,256	2012
	75	5,123	2,759	7,882	2016
	100	6,831	3,679	10,510	Beyond
Benewah Creek	25	2,179	1,174	3,353	2007
	50	4,357	2,347	6,704	2012
	75	6,534	3,519	10,053	2016
	100	8,713	4,692	13,405	Beyond
Evans Creek	25	984	530	1,514	2007
	50	1,968	1,060	3,028	2012
	75	2,951	1,589	4,540	2016
	100	3,935	2,119	6,054	Beyond
Lake Creek	25	2,002	1,078	3,080	2007
	50	4,004	2,156	6,160	2012
	75	6,006	3,234	9,240	2016
	100	8,008	4,312	12,320	Beyond

[a] Target level (percent) is defined as percent improvement over current conditions based on escapement target estimates.

[b] Escapement target is defined as the number of adult fish needed to fully seed available spawning habitat, given the following assumptions:

- Spawning is primarily restricted to 2nd order tributaries (CDA Tribe population data, 1994-1998);
- Usable spawning habitat comprises 4.1% of the total stream area in 2nd order tributaries, when averaged across the four target watersheds (CDA Tribe habitat assessment data, 1998);
- Potential spawning gravel was defined according to Magee et al. (1996) as patches of substrate at least 0.25 m^2 in area with particles 2-35 mm in diameter;
- Average redd size is 0.15m^2 (Magee et al. 1996).
- 1:1.6 male to female spawner ratio (IDFG 1998);
- 3 redds for every 2 spawning females (Scott and Crossman 1973);

[c] Harvest target is calculated as an exploitation rate of 35 percent.

[d] Biological objective is the sum of escapement and harvest targets.

The total number of fish needed to fully seed available spawning habitat was calculated using the following equations:

= Total area of 2nd order streams * 0.041 Ave. redd size (0.15 m^2)

1.5 = 1.6 =

\+ = Estimated total number of adult fish to fully seed available spawning area.

Numbers of returning adults is based solely on the amount of available spawning habitat in the tributaries and not on juvenile carrying capacity. Because the smolt to adult survival estimate has not been completed the escapement estimates are based on total available spawning habitat in each of the target tributaries. Adult return estimates are independent of juvenile rearing carrying capacity estimates. This is because total number of returning adults is comprised of both hatchery and naturally produced fish. Hatchery fish will rear in acclimation ponds separate from the mainstem and tributary rearing areas and are not part of the juvenile carrying capacity estimates.

The harvest goal is 35% of the total numbers of adults returning to the target tributaries once the populations have stabilized and it has been determined that the trend is increasing. Until the 75% objective is met only hatchery fish will be harvested. Total allowable tributary harvest will be based on meeting spawning escapement goals and broodstock needs. No changes to the limited harvest mixed stock fishery in Coeur d'Alene Lake are anticipated until populations of tributary stocks have stabilized and the 75% objective has been met.

5.0 SUPPLEMENTATION APPROACH AND IMPLEMENTATION STRATEGY, GENETIC RISK ASSESSMENT, AND NATIVE FISH INTERACTION ASSESSMENT.

5.1 APPROACH AND IMPLEMENTATION STRATEGY

Supplementation is defined as the stocking of fish into the natural habitat to increase the abundance of naturally reproducing fish populations. Maintaining the long-term genetic fitness of the target population, while keeping the ecological and genetic impacts on non-target populations within acceptable limits, is inherent in this working definition. Our intent is to employ supplementation to seed barren habitat, provide a survival advantage to depressed stocks and speed rebuilding to carrying capacity within the four target watersheds.

On the Coeur d'Alene Indian Reservation, supplementation activities would involve stocking fish into habitats that contain depressed but existing natural fish populations. Unlike many traditional hatchery programs, the objective of supplementation here is to increase the abundance of a naturally reproducing fish populations and therefore, is oriented toward maintaining the natural biological characteristics of the population with reliance on the rearing capabilities of the natural habitat. Supplementation measures will not preclude the need to concurrently pursue other necessary actions such as habitat protection and improvement, and harvest management to rebuild stocks. The concept is to employ a supplementation program to a level that minimizes the risk of extinction and boosts the population density in the target watersheds such that there is a 95% probability of persistence over the next 100 years as described by McIntyre and Reiman (1995).

The primary role of supplementation, in this case, is to increase the survival rate of the population during its early life history (egg through smolt) relative to its survival rate under natural conditions. It is anticipated that this effort will result in increased adult returns to seed sparsely populated habitats and provide for limited harvest opportunities.

The concept of supplementation is still relatively new and uncertainties still exist about its effectiveness and safety (Cuenco et. al., 1993). Monitoring and evaluation will be used to assess the performance and degree of success for each supplemented stock. The results will be used to guide other proposed supplementation projects. The following elements will be included in the monitoring and evaluation program: clearly defined, quantifiable objectives; performance measures for each objective; an experimental design which will facilitate the decision making process by allowing for adaptive management.

Implementation of the supplementation program will be conducted in three phases. Phase I will be to restore natural production by implementing active and passive stream restoration projects in the target tributaries directed at increasing the natural capability of the stream to support westslope cutthroat trout. Phase II will be to construct an artificial production facility and gather broodstock from each of the four target tributaries and raise and release the progeny into their ancestral drainages. Phase III will be to monitor adult returns and manage the ratio of native and hatchery reared returning adults in order to maintain the genetic fitness of the population spawning in the wild.

5.2 FACILITY OBJECTIVES AND STRATEGIES, PRODUCTION PROFILES, PRODUCTION GOALS, BROODSTOCK SELECTION, STOCKING STRATEGIES, GENETIC CONCERNS

The primary role of the Coeur d'Alene Trout production Facility is mitigation for the loss of anadromous fish harvest as a result of reduction of salmon habitat through construction and operation of Grand Coulee Dam. Given the extent of habitat loss from the encroachment of man into the riparian and adjacent lands of tributaries on the Coeur d'Alene Indian Reservation, it is unlikely that natural production in a recovered ecosystem would support all tribal subsistence, and sports harvest interests. The options, therefore, are (1) to be content with lower production from managed natural populations, and use the facility in a more temporary role (supplementation) for rehabilitation, or (2) to manage for greater harvest potential from a combination of natural and hatchery production focusing harvest efforts primarily on hatchery produced fish. The option selected depends on the actual productivity of the recovered ecosystem. The initial goal is to supplement (option 1) the populations and use monitoring and evaluation of milestones to determine if effective. Results obtained from monitoring and evaluation will be used to determine if option two needs to be implemented.

Historically, option 2 was selected for operation of most artificial production facilities in the Columbia Basin. The growing volume of evidence suggests that facilities operating strictly in this manner (basically on blind faith) have in most instances failed to meet their objectives. Thus, continued declining harvests and the failure of the hatchery programs operated in this manner to prevent depletion eventually convinced fish managers that artificial propagation needed a scientific approach. Recently, operation of these facilities has gone through an extensive review by several different agencies and independent review boards to determine how effective they are in attaining their operational objectives. Concurrently, Congress in 1997 directed the NPPC to review all federally funded artificial production facilities in the Columbia River basin in order to establish a set of policies to be used in operating these facilities. Their goal, as well as, the goals of the other reviewing agencies and independent review boards was to establish a set of scientifically based hatchery operating principles to guide operations to more effectively reach recovery and harvest goals. Appendix (D) contains a summary of these goals, policies and recommendations. These are composed of ideas from several regional studies and reports as well as from regional workshops on this topic. Primary among these sources was the Draft NPPC *Artificial Production Review Vol. I Report and Recommendations of the Northwest Power Planning Council* (1999), *Return to the River* Independent Scientific Group (1996), Report of the National Fish Hatchery Review Panel (1994), *Upstream: salmon and society in the Pacific Northwest* National Academy of Science (1996), and the *Supplementation in the Columbia Basin* Regional Assessment of Supplementation Project (RASP) Bonneville Power Administration (1992).

The goals, policies and recommendations listed in Appendix (D) will be used as a guide for facility operations and supplementation activities with the following being the most critical to the success of the project.

- The manner of use and the value of artificial production must be considered in the context of the environment in which it will be used.

- Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate benefits and address scientific uncertainties.

- Hatcheries must be operated in a manner that recognizes that they exist within ecological systems whose behavior is constrained by larger-scale basin, regional and global factors.

- A diversity of life history types and species needs to be maintained in order to sustain a system of populations in the face of environmental variation.

- Naturally selected populations should provide the model for successful artificially reared populations, in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics.

- The entities authorizing or managing a hatchery facility or program should explicitly identify whether the artificial propagation product is intended for the purpose of augmentation, mitigation, restoration, preservation, research, or some combination of those purposes for each population of fish addressed.

- Decisions on the use of the artificial production tool need to be made in the context of deciding on fish and wildlife goals, objectives and strategies at the subbasin and province levels.

- Appropriate risk management needs to be maintained in using the tool of artificial propagation.

- Production for harvest is a legitimate management objective of artificial production, but to minimize adverse impacts on natural populations associated with harvest management of hatchery populations, harvest rates and practices must reflect or be dictated by the requirements to sustain naturally spawning populations.

- Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.

The hatchery will be expected to produce 10,000 catchable sized rainbow trout (12.5 inches long and ¾- 1 pound apiece) and up to 100,000 fingerling cutthroat trout for supplementation efforts in the target tributaries. The hatchery will also support up to 2000 adult cutthroat trout for use as broodstock. Westslope cutthroat trout have an indeterminate life cycle thus broodstock may be spawned more than one time in successive generations.

Table 5.2.1 Maximum Production Capacity of Coeur d'Alene Trout Production Facility

Number of Fish	Ave. Size/ Ave Weight	Species/Life Stage	Pounds Produced Annually
2,000	20 inch/2.8 lbs.	CTT/ Broodstock	5,600 lbs.
100,000	4 inch/22.6 lbs. per 1000	CTT/ Fingerling	2,260 lbs.
10,000	12.5 inch/780 lbs. per 1000	Rainbow Trout/ Adult	7,800 lbs.
Total 122,000			14,660 lbs.

Broodstock will be collected from each of the four target tributaries. All broodstock will be collected from the same stock in each target tributary. These fish will be collected as migrating juveniles and held until adults in order to minimize affects on the natural populations. Each year 100-200 juveniles will be collected from the same sites in the target watersheds. These fish will be individually marked and placed into separate raceways. As these fish mature they will be used as broodstock.

The hatchery will be designed for artificial spawning of coldwater salmonids. Standardized methods for mating described by Piper et. al. (1982) will be used to protect and preserve localized adapted traits. The artificial method of spawning will consist of manually stripping the sex products from the fish, mixing them in a container, and placing the fertilized eggs into an incubator. The spawning method will be designed to reduce handling of fish. The eggs will be hand stripped from a female by gently grasping the fish near the head with the right hand and the body with the left hand. The fish is then held with the belly downward over a pan where the eggs are forced out. Milt is then added from the male expressed in a similar manner. Water is added to wash the eggs prior to incubation.

Cutthroat trout will be initially stocked as juveniles. They will be placed in an acclimation pond adjacent to the individual target tributary. The pond will be fed with water from the stream. Fish when ready will be released and allowed to leave the pond on their own volition. If adult returns are poor from this stocking strategy then other types of stocking will be experimented with (i.e. fry plant). Certified eyed rainbow trout eggs will be purchased and raised in the hatchery. When ready the fish will be outplanted into the catchout ponds. As fish are removed from the pond more will be added up to 2,000 per pond annually.

5.3 MONITORING AND EVALUATION PLAN

Coeur d'Alene Tribe Fish Water and Wildlife personnel realize that effective monitoring is critical to a successful adaptive management program. Effective monitoring determines whether the action completed achieved the objective. Since monitoring activities may overlap, they will be developed into an integrated plan. This monitoring plan will be revised and amended as part of the adaptive monitoring process. This adaptive management process is specifically recommended in section 2.2H of the 1994 NPPC F&W program.

In the face of scientific uncertainty, monitoring and evaluation provides insight into the actual result of an action, as well as, explain the outcome in achieving predicted results. The Coeur d' Alene Tribal Fish, Water and Wildlife project biologists and managers will initiate a program for supplementation that will ensure projects are implemented as intended, experimental studies provide reliable results, and that risks associated with uncertainties are minimized. It also ensures efficiency, prevents duplication of efforts, and tracks progress towards meeting objectives. The monitoring and methods of the plan will consist of, but not be limited to, the following:

1) Quality control: monitoring the performance of the facility and their operators. Standards would be developed for all fish culture and data collection. Monitoring procedures would be included in the operation manuals for all associated activities of the facility.

2) Product specification attributes: monitoring the Coeur d' Alene Tribal hatchery to determine whether the fish produced meet goals with respect to: fish health; morphology (size and shape); behavior and survival.

3) Monitoring of stock status: measurements of run size and escapement to determine whether harvest objectives are being met while aiding in natural production. Monitoring will provide information essential to track long-term performance and fitness of the fish population

4). Research monitoring activities: include measurements of performance in four main areas. These areas are: a) post-release survival (survival from time of release until the time the fish returns to spawn); b) reproductive success (number of offspring produced per spawner); c) long-term fitness (genetic diversity and long-term stock productivity), and d) ecological interactions (population abundance and distribution, growth rates, carrying capacity, survival rates, transfer of disease, and gene flow).

Implementation of the monitoring plan, annual review of the findings, and subsequent adjustment, as necessary, of the supplementation program completes the feedback loop that is essential to the success of the adaptive management process, and ultimately, the entire project.

5.3.1 STEPS TO COMPLETE MONITORING AND EVALUATION PLAN

Objective ***Monitor and evaluate the hatcheries effectiveness in increasing the numbers of fish harvested and returning to spawn in Reservation waters.***

Task *Enumerate the number of naturally produced migrating juveniles vs. hatchery produced juveniles.*

1. Operate outmigrant traps to monitor outmigration of wild and hatchery adfluvial fish. Fish captured will be sub-sampled to collect data on length, weight and origin (hatchery or natural). Trap efficiency will be determined through mark and recapture of known numbers of juvenile trout.
2. Monitor resident fish species composition through snorkel count and/or electrofishing in index areas.

Product: Report containing information from migration traps including migration timing, number of hatchery vs. wild, habitat use by hatchery and wild fish. **Completion date:** Ongoing for duration of project

Task *Enumerate the number of migrating adults returning to spawn in Reservation waters.*

1. Install and monitor upstream traps to enumerate returns.
2. Radio tag adult fish destined for return to treatment streams. As adult fish are detected and trapped at the weirs, radio tag and tack fish to determine movement pattern and length of time prior to spawning.
3. Conduct cutthroat trout redd count surveys in spawning areas to determine spawner distribution. Collect biological information from population, as well as, determine origin.
4. Collect and analyze the creel census data obtained from tributaries and Coeur d'Alene Lake.

Product: Report containing migration timing, spawning locations, numbers returning, trapping efficiency, hatchery vs. wild, habitat use by wild and hatchery adults. **Completion date:** Ongoing for duration of project first release in FY2001and first adult returns expected FY2004.

Task *Assess impacts of exotic species interactions with supplemented fish stocks in both Coeur d'Alene Lake and the target watersheds.*

1. Monitor interactions between resident trout and outplanted fish, as well as, interactions with other biota and other species of concern where applicable, by outmigrant traps, snorkel surveys, and electrofishing in watersheds where fish populations have been supplemented.
2. Monitor interactions between outplanted fish and exotic species in Coeur d'Alene Lake. Conduct predator-pray analysis in littoral zones of Coeur d'Alene Lake affected by hydropower operations.

Task *Evaluate effectiveness of current harvest policies and enumerate hatchery contribution to creel.*

1. Increase harvest opportunities for fishers consistent with requirements of genetic, natural production, and experimentation objectives.
2. Use selective and/or "status index harvest" policies to increase harvest opportunities for fishers.
3. Provide a subsistence fishery of 0.5 fish/hr in catch-out trout ponds.
4. Obtain rainbow trout creel condition factors ($K>152 \times 10^{-7}$)

Product: Report detailing makeup of creel with hatchery to wild comparisons
Completion date: Ongoing for duration of project first report in FY2002

Task *Maintain coordination with other tribal programs and activities.*

1. Monitor, review, and comment on other agency activity in streams and watersheds where supplementation has been planned and take appropriate actions to protect watersheds crucial to the success of the project.

Product: Coordinated releases of hatchery fish
Completion date: Ongoing duration of project

Task *Monitor and review compliance with hatchery operation manual for all hatchery related activity.*

1. Continue bacterial and viral sampling of adults during spawning operations.
2. Continue proper fish culture techniques.

Product: Complete hatchery production evaluation forms. Report containing disease testing results. **Completion date**: Ongoing for duration of project first report one year after operations begin.

6.0 EXPECTED PROJECT BENEFITS- COST BENEFIT RATIO

Expected benefits from the Coeur d'Alene Tribal Trout Facility include:
Production of up to 20,000 catchable sized rainbow trout for stocking in Tribal trout ponds.
Increases in the current distribution of westslope cutthroat trout on the Reservation and in Coeur d'Alene Lake.
Using habitat restoration in conjunction with supplementation to increase the abundance of westslope cutthroat trout on the Reservation and in Coeur d'Alene Lake.
Double the current number of naturally produced returning adults in each of the four target tributaries, while providing a harvestable surplus, within 10 years of construction of the facility.
Reduce the risk of extinction for westslope cutthroat trout in the four target tributaries such that there is a 95% probability of persistence over 100 years for each target tributary.
Provide over 80,000 angler hours of opportunity with a catch rate of 0.5 fish/hour at the Tribal catch-out ponds annually.

Estimated construction costs for the proposed facility are detailed in Appendix (E).

7.0 CONSISTENCY WITH THE COEUR D'ALENE TRIBES FISHERIES MANAGEMENT PLAN, WITH NPPC POLICIES, OTHER RECOVERY PLANS AND COORDINATION ISSUES

This section outlines the Coeur d'Alene Tribe Fish, Water and Wildlife Programs fisheries management plan and details how this project fits into the overall program as well as other regional management and recovery plans

7.1 FISHERIES MANAGEMENT PLAN

Overarching goals for the program includes: 1.) Protection, mitigation, and enhancement of Columbia River Basin native resident fish resources. 2.) Develop, increase, and reintroduce natural spawning populations of westslope cutthroat trout into reservation waters. 3.) Provide both short and long-term harvest opportunities for the reservation community. 4.) Sustain long-term fitness and genetic integrity of targeted fish populations. 5.) Keep ecological and genetic impacts to non-targeted fish populations to a minimum. We stress the need to restore the natural functions of the Coeur d'Alene subbasin ecosystem that produce salmonid fishes, as opposed to circumventing natural ecological processes. These five concepts will provide the framework to guide planning and implementation of the Coeur d'Alene Tribe's Fisheries Management Plan.

In 1994, the Northwest Power Planning Council adopted the recommendations set forth by the Coeur d'Alene Tribe to improve the Reservation fishery. These actions included: 1.) Implement habitat restoration and enhancement measures in Lake, Benewah, Evans and Alder creeks; 2.) Purchase critical watershed areas for protection of fisheries habitat; 3.) Conduct an educational/outreach program for the general public within the CDA Reservation to develop a "holistic" watershed protection process; 4.) Develop an interim fishery for tribal and non-tribal members of the reservation through construction, operation and maintenance of trout ponds; 5.) Design, construct, operate, and maintain a trout production facility; and 6) Implement a five-year monitoring program to evaluate the effectiveness of the hatchery and habitat improvement projects.

The Coeur d'Alene Tribe Fish, Water and Wildlife Program will implement the six Council approved actions in the following manner.

1.) <u>Implement habitat restoration and enhancement measures in the four target watersheds. As well as, purchase critical watershed areas for protection of fisheries habitat.</u>

This will be completed in the following manner. Analyze existing information and prioritize potential projects consistent with management guidelines. Negotiate and sign landowner contracts. Develop site specific plans, obtain permits and submit project descriptions to BPA and participating agencies for supplemental analysis and review. Implement priority projects that can demonstrably improve watershed conditions by reducing sediment delivery and transport, improve water quality and quantity, and increase riparian and instream habitat diversity. Conduct maintenance activities at existing project sites as necessary. Products include signed landowner contracts and written project descriptions. BPA is providing funding to the Coeur d'Alene Tribe to acquire 2,100 acres of high quality riparian wetlands and adjacent upland habitat in the Lake Creek watershed (9004401). This acquisition will secure critical habitat for protection of fish, water and wildlife, allow for enhancement of degraded areas. Expected benefits are reduced sediment loading, improved water quality and quantity, and improved riparian and instream habitat diversity in target watersheds.

A conceptual approach to the restoration of fish habitat has been adapted from various sources as a guide for management efforts on the Reservation (Lillengreen 1998; National Research Council 1992; Kauffman et. al. 1993). The conceptual model is based on the ecological processes that shape riparian/stream ecosystems and focuses on 1) removing or modifying those land use impacts that are causing habitat degradation, 2) re-establishing riparian/stream linkages, and 3) restoring natural ecosystem processes.

The desired future condition for target watersheds has been defined as being functionally equivalent to the potential natural community. In other words, the goal is to restore those essential ecological conditions and processes necessary to maintain diverse and productive resident trout populations. This concept recognizes that a number of human-caused factors will preclude a complete return to the historical condition. However, under this scenario ecological processes (succession, natural disturbances, competition, evolution, etc.) and hydrological processes (sediment transport and deposition, flood plain storage and subsurface recharge, nutrient cycling, etc.) function in such a manner as to ensure a sustainable intact ecosystem. Such a system has the potential to support a healthy resident trout fishery.

- Task: Identify stream reaches needing some level of enhancement based on physical and biological conditions and watershed assessments, then prescribe appropriate restoration techniques. Restoration projects will be prioritized using a cost/benefit analysis that considers the potential for long-term ecological recovery and landowner participation.

  Priority areas for restoration treatment have been identified in the Coeur d'Alene Tribe Project Management Plan (Lillengreen et. al. 1998). These areas occur where existing habitat conditions (e.g., average residual pool depth, average canopy cover, number of large woody debris/lineal distance, riffle/pool ratio, and average percent fines) fall short of optimal conditions for the target species as defined by habitat suitability indices (Hickman and Raleigh 1982). Seasonal, temporary violations of water quality criteria and low trout abundance are secondary indications of a need for treatment at these sites. Projects that will restore habitat linkages to highly productive habitats upstream have the greatest potential for increasing the abundance and distribution of trout.

- Task: Sign landowner agreements for high priority implementation projects. A generalized landowner agreement has been developed that creates a legal foundation to establish the commitments of the landowner and the Coeur d' Alene Tribe Natural Resource Department, while addressing liability issues. Several exhibits that specifically identify the location of the project and define the work to be accomplished accompany the agreement. The terms of the agreement are flexible, but have been long reaching enough (10-25 years) to ensure that monitoring and evaluation procedures can be completed.

  An average of three new landowner agreements have been signed each year during 1997 and 1998. In addition, new projects have been implemented as part of existing agreements. Landowner interest in restoration projects has increased as demonstration projects are scrutinized. We estimate that between 3-5 new agreements will be signed in FY2000.

- Task: All projects will be described and submitted to participating agencies and BPA for a final review prior to implementation. Past data collection efforts for the project site will be described and data gaps will be identified to facilitate implementation and effectiveness monitoring. Project specific goals and objectives that are quantifiable and measurable will be developed. These objectives will be consistent with biological objectives identified in the FWP and should facilitate the implementation of monitoring and evaluation procedures (NPPC 1994). Project implementation will be coordinated with the appropriate regulatory agencies so that all pertinent applications and permits may be obtained.

- Task: This program will continue to implement riparian enhancement projects as a primary means of restoring ecological function. Control of livestock utilization will be done through construction of exclusion fences and development of off-site water sources. Degraded riparian areas will be restored as needed by planting native shrubs and trees, seeding with grasses and sedges, and controlling noxious weeds. Streambank stability will be improved on a site-specific basis using bioengineering techniques. Information on planting techniques and considerations for riparian rehabilitation has been based on the work of several authors (Lambert and Boswell, 1994; Hoag, 1991; 1993; Van Haveren and Jackson, 1986; USDA, 1981).

- Task: Increase instream habitat diversity through placement of large wood, boulders or other native materials in order to enhance juvenile fish rearing habitat. Side channels will be reconnected to mainstem reaches where severe degradation of the channel has resulted in isolation from the floodplain. Many of the techniques to be used have been previously compiled by Hunt (1993).

- Task: This program will continue to implement wetland enhancement projects in areas that historically supported hydric soils and wetland vegetation. Projects will consist of constructing excavated and embankment ponds that capture and store surface water runoff. Target sites have been identified using GIS technology that overlays information on drainage density, soil erosion hazard, land use and vegetative cover type, channel function, and fish abundance and distribution (Montgomery and Buffington 1993; Washington Forest Practices Board 1997). High priority sites are located at the lower end of small (>200 acres) subbasins dominated by agricultural activities that have generally been managed to promote rapid surface water runoff. Soil erosion hazard and transport at these sites is severe.

  Implementation of these projects decreases transport of non-point source sediment from source areas to sensitive stream reaches, promotes local infiltration of water, increases the diversity of native plant communities and provides habitat for wildlife.

2.) <u>Conduct an educational/outreach program for the general public within the CDA Reservation to develop a "holistic" watershed protection process.</u>

In order to increase the public's awareness of the Coeur d'Alene Tribe's Fisheries Restoration Program and to involve the Reservation community and affected parties in a meaningful public involvement and education process, the following goals and objectives were identified

- Encourage landowner and public support and guidance in the identification of creative solutions to land use problems impacting fisheries habitat in the study drainages.
- Develop and coordinate landowner, community and agency coalitions that would address issues related to habitat restoration efforts.
- Develop and distribute educational literature on fish habitat restoration.
- Develop and implement an outreach effort for all interested parties, including special interest groups, schools, and agencies.
- Develop educational components to be utilized by the local schools, clubs (i.e.4-H), community groups, etc.

Two parallel processes have been designed to achieve these goals. One process focuses on addressing methods of fostering landowner cooperation and modifying land use practices that impact fisheries habitat. The second process focuses on promoting the general public's awareness of fish habitat and watershed health issues and increasing the public's awareness of the Coeur d'Alene Tribes compensatory harvest program.

The first process involves formulation of watershed working groups comprised of local land-owners, special interest groups (primarily active sportsman groups in the local watersheds), and interested agencies. The watershed working groups are responsible for assisting in the identification of problems in the watershed and developing long-term methods of improving fisheries habitat. These working groups are also responsible for gaining public support and cooperation with the restoration program. The watershed groups help identify and solicit other sources of revenue to expand the restoration effort.

The second process involves a "public relations" campaign or "marketing program". This process focuses on educating the general public about the importance of fish habitat and watershed health issues. This campaign targets civic organizations, local schools, the general public and other interested parties. The educational campaign also prepares and gives presentations pertaining to the needs of and protection of fisheries habitat. Field trips to showcase restoration projects are offered as well as publication and distribution of quarterly news letters.

3.) <u>Develop an interim fishery for tribal and non-tribal members of the reservation through construction, operation and maintenance of trout ponds.</u>

Since harvest of fish remains an ongoing subsistence activity for many Tribal members, there is a need to reduce fishing pressure on wild fish stocks while giving restoration efforts a chance to benefit the ecosystem. Over the last several years, poor fishing conditions have severely limited the ability of the Tribal Community to harvest desirable fish species in any acceptable numbers. The Coeur d' Alene Tribe has made the difficult decision to maintain a strict wild fish management policy for traditional fishing areas, primarily important cutthroat trout streams on the Reservation. The emphasis is to restore these areas in order to optimize conditions for expansion of wild stocks (restoration of habitat). However, substantial increases to these populations to support any sizable harvest goals are not expected for some time.

Since the Coeur d'Alene Tribe decided to close streams to harvest in sensitive drainages on the Reservation as the principal method of protecting and promoting wild stock expansion, a hatchery oriented "put and take" fisheries program using rainbow trout was implemented. To provide for reasonable harvest of desired species in the near future it was decided that a series of trout fishing ponds located in strategic areas would best serve the need for an alternative fishery on an interim basis. To protect the integrity of the wild fish restoration projects none of these ponds are to be placed in drainages where restoration is occurring. This will minimize the chance of interaction between hatchery and native fish species. Additionally, all ponds will be closed basin fisheries to prevent genetic introgression as well as spread of disease.

4.) <u>Design, construct, operate, and maintain a trout production facility to provide fish for supplementation of wild stocks of westslope cutthroat trout and produce rainbow trout for stocking in a "put and take" fishery in catchout ponds located in and around the Reservation.</u>

The Coeur d'Alene Tribe Trout Production Facility is intended to rear and release westslope cutthroat trout into rivers and streams with the express purpose of increasing the numbers of fish spawning, incubating, and rearing in the natural environment. It will use the modern technology that hatcheries offer to overcome the mortality occurring in lakes, rivers, and streams after eggs are laid in the gravel. The facility will also produce rainbow trout for stocking in local trout ponds for "put and take' fisheries. The details are to be discussed, in depth, in this document

5.) <u>Implement a monitoring program to evaluate the effectiveness of the hatchery and habitat improvement projects.</u>

Task: Enumerate the number of naturally produced migrating juveniles vs. hatchery produced juveniles.

- Operate outmigrant traps to monitor outmigration of wild and hatchery adfluvial fish. Fish captured will be sub-sampled to collect data on length, weight and origin (hatchery or natural). Trap efficiency will be determined through mark and recapture of known numbers of juvenile trout.
- Monitor resident fish species composition through snorkel count and/or electrofishing in index areas.

Task: Enumerate the number of migrating adults returning to spawn in Reservation waters.
- Install and monitor upstream traps to enumerate returns.
- Radio tag adult fish destined for return to treatment streams. As adult fish are detected and trapped at the weirs, radio tag and tack fish to determine movement pattern and length of time prior to spawning.
- Conduct cutthroat trout redd count surveys in spawning area to determine spawner distribution. Collect biological information from population, as well as, determine origin.
- Collect and analyze the creel census data obtained from tributaries and Coeur d'Alene Lake.

Task: Assess impacts of exotic species interactions with supplemented fish stocks in both Coeur d'Alene Lake and the target watersheds.
- Monitor interactions between resident trout and outplanted fish, as well as, interactions with other biota and other species of concern where applicable, by outmigrant traps, snorkel surveys, and electrofishing in watersheds where fish populations have been supplemented.
- Monitor interactions between outplanted fish and exotic species in Coeur d'Alene Lake. Conduct predator-pray analysis in littoral zones of Coeur d'Alene Lake affected by hydropower operations.

Task: Evaluate effectiveness of current harvest policies and enumerate hatchery contribution to creel.
- Increase harvest opportunities for fishers consistent with requirements of genetic, natural production, and experimentation objectives.
- Use selective and/or “status index harvest” policies to increase harvest opportunities for fishers.
- Provide a subsistence fishery of 0.5 fish/hr in catch-out trout ponds.
- Obtain rainbow trout creel condition factors ($K>152 \times 10^{-7}$)

Task: Trend monitoring of abiotic and biotic factors is an ongoing component of this project.
- Measurements of abiotic factors (e.g. stage/discharge, temperature, dissolved oxygen, pH, conductivity, turbidity, TSS, nutrients) are tracked at 10 sites within the target watersheds.
- Temperature is measured continuously, while other parameters are measured weekly from April through October.

Task: Effectiveness monitoring will be used to evaluate individual restoration projects.
- Techniques include: population assessments that describe habitat utilization; physical habitat assessments that describe changes to channel morphology, hydrology, and riparian function; and water quality assessments that document fluctuation in temperature and dissolved oxygen over time.
- Methods for Evaluating Riparian Habitats with Applications to Management (Platts et. al. 1987) is used as a guidance document for selecting appropriate habitat variables and methods.

Task: Maintain coordination with other tribal programs and activities.
Monitor, review, and comment on other agency activity in streams and watersheds where supplementation has been planned and take appropriate actions to protect watersheds crucial to the success of the project.

7.2 CONSISTENCY WITH OTHER PROGRAMS AND REGIONAL MANAGEMENT AND RECOVERY PLANS

Adfluvial cutthroat trout are the target species for supplementation. They are species of special concern throughout the region. The status of westslope cutthroat trout as threatened or endangered over its entire range is currently under review by the U.S. Fish and Wildlife. This program will participate in as well as help to develop any recovery plans for ESA listed species located on the Reservation or affected by activities conducted.

This project shares the NPPC Fish and Wildlife Program objectives (see section 10.1 NPPC F&W Program) of maintaining biological diversity in the Upper Columbia River basin; maintaining genetic integrity by preserving wild fish stocks; providing needed habitat protection; and increasing run sizes of resident fish populations by implementing effective restoration projects in conjunction with hatchery supplementation. The hatchery will provide fish for supplementation projects directed at increasing the biological diversity of species of special concern (westslope cutthroat trout). Stocks will be supplemented in the target tributaries according to strict guidelines developed for maximizing biological diversity and minimizing impacts to the naturally reproducing population. The genetic integrity will be maintained by using only fish that are not first-generation hatchery for broodstock. Fish will be segregated and hatchery reared progeny will only be released into ancestral drainages. Less than 50% of the natural-origin returning adult escapement from each target tributary will be used for broodstock purposes. In addition, the proportion of natural-to-hatchery origin adults allowed to spawn naturally will be managed.

The Bonneville Power Administration has committed itself to protecting and enhancing the native fish resources of the Coeur d'Alene Indian Reservation as a means of partially mitigating impacts of the Columbia River Hydroelectric System. This project will address partial mitigation (out-of-place, out-of-kind) for anadromus fish losses in the Upper Columbia River basin through a resident fish substitution program. The Coeur d'Alene Tribe Trout Production Facility construction project is one of many ongoing efforts directed at mitigating losses attributed to construction of Grand Coulee and Chief Joseph Dams. The project is also an integral part of the Columbia Basin Fish and Wildlife Authority multi-year plan.

The Coeur d'Alene Tribe Fish, Water and Wildlife program is based on watershed management that equally protects and enhances fish and wildlife resources throughout the Reservation. The project will provide fish for reservation streams and the trout ponds based on results from other Coeur d'Alene Tribal program projects. Other program projects include:

<u>Lake Creek Land Acquisition and Enhancement (9004401)</u>
This project is part of an ongoing effort by the Coeur d'Alene Tribe and the Bonneville Power Administration to protect, enhance, and maintain high value fish and wildlife habitat in the Lake Creek Watershed.

<u>Water Resources</u>

The EPA is working with the Water Resources Division of the Coeur d'Alene Tribe Fish, Water, and Wildlife program under sections 319 and 106 of the Clean Water Act to reduce non-point source pollution and to gather baseline water quality data in the four target watersheds. Implementation priorities for this program are 1.) The reduction of sediment outputs from agricultural sheet and rill erosion; 2.) The restoration of riparian zones and increasing of streambank canopy cover; 3.) The augmentation of base flows; and 4.) The mitigation of flow disturbances and sedimentation due to forest roads.

Additionally, local soil conservation districts have received State Agricultural Water Quality Program (SAWQP) grants to fund projects that reduce non-point source pollution from cropland erosion. The

Kootenai-Shoshone Soil Conservation District recently enrolled 55% of the Lake Creek agricultural acreage within Idaho into the State Agricultural Water Quality Program (SAWQP). This commits watershed producers to a variety of agricultural BMP's including conversion to bluegrass. The majority of the contracts written are in their first two years of a five-year implementation plan. As the contracts are completed, the Lake Creek watershed should receive reduced sediment loads. Tribal Fish, Water, and Wildlife Program staff are coordinating fish and wildlife habitat restoration efforts with this agency so that critical areas receive priority treatment. This project is also consistent with the IDFG management goal of conserving and enhancing native fish stocks throughout the region.

13.0 References

Allendorf, F. W. & Phelps, S. R. 1981. Use of allelic frequencies to describe population structure. Canadian Journal of Fisheries and Aquatic Sciences 38: 1507-1514.

Behnke, R.J. 1979. Monograph of the native trouts of the genus *Salmo* of western North America. Rep. prepared for U.S. Fish and Wildlife Service, Region 6, Denver, CO. 215pp.

Behnke, R.J. and M. Zarn. 1976. Biology and management of threatened and endangered western trout. U.S. Forest Service General Technical Report RM-28. 45pp.

Bell, M.C. 1973. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps Eng., North Pacific Division, Contract DACW57-68-C-0086. 92pp.

Binns, N.A. and F.M. Eiserman. 1979. Quantification of fluvial trout habitat in Wyoming. Transactions of the American Fisheries Society 108:215-228.

Conder , A.L. and T.C. Annear. 1987. Test of weighted usable area estimates derived from PHABSIM model for instream flow studies on trout streams. North American Journal of Fisheries Management 7:340-350.

Cuenco, M.L., T.W.H. Backman and P.R. Mundy. 1993. *in*: J.G. Cloud and G.H. Thorgaard (eds.), Genetic Conservation of Salmonid Fishes. Plenum Press, New York, New York.

Ellis, M.N. 1932. Pollution of the Coeur d'Alene River and adjacent waters by mine wastes. U.S. Bureau of Fisheries. Mimeo Report. 55p.

Graves, S., K.L. Lillengreen, D.C. Johnson, and A.T. Scholz. 1992. Fisheries habitat evaluation on tributaries of the Coeur d'Alene Indian Reservation: Annual Report, 1990. Project Number 90-044. Bonneville Power Administration. Portland, OR.

Griffith, J.S. 1993. Coldwater streams. Pages 405-425 *in* C.C. Kohler and W.A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

_______. 1988. Review of competition between cutthroat trout and other salmonids. American Fisheries society Symposium 4:134-140.

_______. 1972. Comparative behavior and habitat utilization of brook trout (*Salvelinus fontinalis*) and cutthroat trout (*Salmo clarki*) in small streams in northern Idaho. Journal of the Fisheries Research Board of Canada 29:265-273.

Hartl. D. L. & Clark, A. G. 1997. Principles of population genetics. Sinauer Associates, Inc., Sunderland, MA.

Hickman, T. and R.F. Raleigh. 1982. Habitat suitability index models: Cutthroat trout. USDI, Fish and Wildlife Service. FWS/OBS-82/10.5. 38 pp.

Hoag, J.C., G.L. Young, and J.L. Gibbs. 1991. Planting techniques for vegetating riparian areas from the Aberdeen Plant Materials Center. Paper presented at The 45th Annual Meeting of the Society for Range Management, Spokane, WA. 6pp.

Hoag, J.C. 1993. How to plant willows and cottonwoods for riparian rehabilitation. In: Proceedings-Streambank Stabilization Workshop: Bioengineering Techniques. Pendleton, OR, February, 1995.

Horowitz, A.J., Elrick, K.A. Robbins, J.A., and Cook, R.B. 1994. Effect of mining and related activities on the sediment trace element geochemistry of Coeur d'Alene Lake, Idaho, USA. Part II subsurface sediments Hydrological Processes. V. 8 pg.

Hunt, R.L. 1993. Trout Stream Therapy. University of Wisconsin Press, Madison, Wisconsin. 74 pp.

IDFG. 1998. Letter to USFWS Regarding petition to list westslope cutthroat trout as threatened under the endangered species act.

Kauffmann, J.B., R.L. Beschta, and W.S. Platts. 1993. Fish habitat improvement projects in the Fifteenmile Creek and Trout Creek basins of central Oregon: Field review and management recommendations. Bonneville Power Administration. Portland, OR.

Lambert, S.M., and M. Boswell. 1994. Selecting, preparing, and handling native plant materials. In: Proceedings-Streambank Stabilization Workshop: Bioengineering Techniques. Pendleton, OR, February, 1995.

Levell, J.H., L. A. Petersen, and G.E. Nichols. 1987. Placer mining technology and associated environmental effects. Salisbury and Associates, Inc., Spokane, WA.

Liknes, G.A. 1984. The present status and distribution of the westslope cutthroat trout (*Salmo clarki lewisi*) east and west of the continental divide in Montana. Report to Department of Fish, Wildlife and Parks, Helena.

Liknes, G.A. and P.J Graham. 1988. Westslope cutthroat trout in Montana: Life history, status, and Management. American Fisheries Society Symposium. 4:53-60.

Lillengreen, K.L., Tami Skillingstad, and Allen T. Scholz. 1993. Fisheries habitat evaluation on tributaries of the Coeur d'Alene Indian Reservation. Bonneville Power Administration. Division of Fish and Wildlife. Portland Or. Project # 90-44. 218p.

Lillengreen, K.L., A.J. Vitale, and R.L. Peters. 1996. Fisheries habitat evaluation on tributaries of the Coeur d’Alene Indian reservation, 1993-1994 annual report. USDE, Bonneville Power Administration, Portland, OR. 260p.

_______. 1999. Coeur d’Alene Tribe program management plan –enhancement of resident fish resources within the Coeur d’Alene Indian Reservation. *In press*: U.S. Department of Energy, Bonneville Power Administration Project Number 90-044. Portland, OR.

Magee, J.P., T.E. McMahon and R.F. Thurow. 1996. Spatial variation in spawning habitat of cutthroat trout in a sediment-rich stream basin. Tran. Am. Fish. Soc. 126:768-779.

McIntyre, J.D. and Reiman, B.E. 1995. Westslope cutthroat trout. *in* Conservation Assessment for Inland Cutthroat Trout. Michael K. Young Technical Editor. USDA Forest Service General Technical Report RM-GTR-256. pg. 1-16.

Montgomery, D.R. and J.M. Buffington. 1993. Channel classification, prediction of channel response, and assessment of channel condition. Wash. Edpt. Nat. Res. Rep. TFW-SH10-93-002. Olympia, WA. 86p.

National Research Council (NRC). 1992. Restoration of Aquatic Ecosystems. National Academy Press, Washington, D.C. 552 pp.

Nelson, R.L., M.L. McHenry, and W.S. Platts. 1991. Mining. American Fisheries Society Special Publication 19:207-296.

Northwest Power Planning Council. 1994. Columbia River Basin Fish and Wildlife Plan.

Peters, R.L., A.J. Vitale and K.L Lillengreen. 1999. Supplementation Feasibility Report on the Coeur d'Alene Indian Reservation. Project Number 90-044. Bonneville Power Administration. Portland, OR. 156p.

Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1982. Fish Hatchery Management. USFWS. Department of Interior. Washington D.C. GPO. 517p.

Platts, W.S., and 12 coauthors. 1987. Methods for evaluating riparian habitats with applications to management. USDA Forest Service, General Technical Report, INT-221. 177 pp.

Rieman, B.E. and Apperson, Kimberly A. 1989. Status and Analysis of Salmonid Fisheries. Westslope Cutthroat Trout Synopsis and Analysis of Fishery Information. Appendix A. Project F-73-R-11. Idaho Department of Fish and Game. 79(Article 06).

Rieman, B.E. and J.D. McIntyre. 1993. Demographics and habitat requirements for observation of bull trout. General Technical Report INT-302. U.S.F.S. Intermountain Research Station, Boise, ID.

Rieman, B.E., and D.L. Myers. 1997. Use of redd counts to detect trends in bull trout (*Salvelinus confluentus*) populations. Conservation Biology 11:1015-1018.

Schill, D.J. and R.L Scarpella. 1997. Barbed Hook Restrictions in Catch and Release Trout Fisheries: A social Issue. N. American Journal of Fisheries Management. 17:873-881.

Scholz, A.T., D.R. Geist, and J.K. Uehara. 1985. Feasibility report on restoration of Coeur d'Alene Tribal Fisheries. Upper Columbia United Tribes Fisheries Center. Cheney, WA. 85 pp.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. J. Fish. Res. Bd. Can., Bulletin 184.

U.S. Department of Agriculture. 1984. General soil map and landform provinces of Idaho: Boise, Idaho. Soil Conservation Service. 1p.

U.S. Department of Agriculture. 1998. Biological Assessment St. Joe and North Fork Clearwater Rivers. US Forest Service.

Varley, J.D. and R.E. Gresswell. 1988. Status, ecology, and management of the Yellowstone cutthroat trout. American Fisheries Society Symposium 4:13-24.

Vitale, A.J., R.L. Peters, D.A. Bailey, and K.L. Lillengreen. 1999. Implementation of fisheries enhancement opportunities on the Coeur d'Alene Indian Reservation. 1998 Annual Report . *In press*: U.S. Department of Energy, Bonneville Power Administration Project Number 90-044.

Washington Forest Practices Board. 1997. Standard methodology for conduting watershed analysis. Version 4.0. Olympia, WA.

Zaroban, D.W. 1996. Forest Practices Water Quality Audit. Idaho Dept. of Health and Welfare, 1410 N. Hilton, Boise, ID

Appendix A

Conceptual Hatchery Design

Production Goals

The Coeur d'Alene trout production facility will support up to 2000 adult cutthroat trout for use as broodstock. These fish will be collected as fry and held until adults in order to minimize effects on the natural populations. It is anticipated that four years will be required to produce viable cutthroat broodstock at the new production facility. The facility will then be expected to produce up to 100,000 fingerling cutthroat trout for supplementation efforts in the four target tributaries. The facility will also be expected to produce up to 10,000 catchable sized rainbow trout. Table 1 presents a summary of annual production goals for the new facility.

Table 1 - Maximum Annual Production Capacity of Coeur d'Alene Tribal Trout Facility

Number of Fish	*Size/Weight*	*Species/Life Stage*	*Pounds Produced*
2,000	20 inch/2.8 lbs	CTT/Broodstock	5,600
100,000	4 inch/22.6 per 100	CTT/Fingerling	2,260
10,000	12.5inch/780 per 100	Rainbow Trout	7,800
Total 112,000			15,660 lbs

Cutthroat trout will be initially stocked as 4-inch fingerlings. They will be placed in four individual acclimation ponds—each one adjacent to the individual target tributary. The acclimation pond will be fed with water from the stream. Fish when ready will be released and allowed to leave the pond on their own volition. If adult returns are poor from this stocking strategy, then stocking with fry will be experimented with. This will entail the annual production and stocking of up to 500,000 1.5-inch cutthroat fry. Such a stocking strategy, if needed, will not be implemented for at least 8 years after start-up of the new facility.

Hatchery Building
A new 3,150 square-foot hatchery building will be constructed to enable the efficient production of up to 150,000 trout fry. Water from a new well will be aerated, filtered and chilled to 45-50° F for incubating cutthroat trout eggs (to match natural fry-emergence temperatures) during the period of mid-April through early July. Approximately 20 gpm of such treated water will be required for the hatching operation. Certified eyed rainbow trout eggs will be purchased and also incubated in this building during the period of July and August. Fry from both species will be overwintered in the hatchery building until ready to be released in the outdoor production facilities. Table 2, found on the next page, presents a production program timetable for both cutthroat and rainbow trout at the new facility.

Newly hatched fry will be placed in fiberglass troughs of the following approximate dimensions: 2 ft. wide by 1.33 ft. deep and 8 ft. long. The usable space in each trough is 14 ft.^{3}, based on a maximum freeboard of 4-inches (0.33 ft). The downstream 12-inch length of each trough is blocked off by an overflow weir, and thus does not contribute to usable space. A total of 20 such troughs will be provided for fry rearing — 16 troughs for cutthroat fry, 3 for rainbow fry, plus 1 spare trough.

Each of the 16 cutthroat fry troughs will be supplied with 7 gpm of treated water at a temperature of 48 to 52° F. Each trough will be capable of holding 8,100 l.5-inch fry at a density index (D.I.) of 0.46. The resultant flow index (F.I.) at this density is an acceptable 0.93. For the overwintering of approximately 15,000 1.8-inch rainbow fry (2.2 lbs. per 1000), only three such troughs will be required at a D.I. of 0.44. These troughs will also receive 7 gpm of treated water, but at a temperature of 58°F to promote faster growth.

The fiberglass troughs described above will have 2 separate drains - an overflow drain that is plumbed to the reuse system, and a cleaning waste drain that will discharge directly into the floor trench drain which is in turn plumbed to the outdoor effluent pond.

An 80 square-foot incubation room, complete with four 8 tray vertical incubators, a large stainless steel sink, a floor drain and a small floor trench will be located adjacent to the fry rearing area.

An outdoor isolation/early rearing covered area, containing four 4-ft. diameter and four 6-ft. diameter round tanks, will be used to hold and observe newly recruited wild cutthroat fry prior to releasing them into the broodstock raceways. This area will be adjacent to the hatchery building and will be covered by extending the roof line of the building.

Other spaces, as outlined on Table 3 and illustrated on Figure 1 will include a small diagnostic lab with counter tops, double sinks and chest freezers for moist feed, as well as

office space, interpretive area, mechanical life support spaces, kitchen/dining area, restrooms and bootroom. There will also be a loft area above the restrooms and bootroom for light materials storage. The mechanical life support spaces will include an aeration column, 2 skid-mounted sandfilters (30-inch diameter) complete with all plumbing and 2 booster pumps, a filter backwash supply storage tank, twin elevated headbox tanks and a chiller. Two 8-lamp U.V. disinfection units will be installed, irregardless of the quality of the groundwater source. All water used in the hatchery building for incubation and fry rearing (140 gpm peak demand) will be treated and disinfected for reuse in the outdoor production facilities, as well as for supplementing first-use hatchery water.

Production Raceways

Approximately 8 months after the newly hatched cutthroat fry are started on feed in the hatchery they will be transferred to the outdoor raceways, where they will be grown from 1.5-inch to the planting size of 4-inch. Their growth within the hatchery will be controlled through manipulation of water temperature and feeding so as to mimic wild growth rates.

Annual production of 100,000 4-inch cutthroat fingerlings over a 20-22 month period will require 4 separate raceways — two raceways for each year class. Assuming a mortality rate of 1.5 percent per month, about 150,000 0.5-inch fry are needed for the production of 100,000 4-inch year 2 fingerlings. Table 4 below presents information for three fish sizes grown in the raceways. It shows that the cutthroat fingerling production program can be achieved with four raceways without exceeding a density index of 0.40 or a flow index of 0.94.

Table 4 – Cutthroat Trout Raceway Production

Fish Size (inches)	*Number/Pounds (per 2 raceways)*	*Density Index (D.I.)**	*Flow Index (F.I.)***
1.5	130,000/156	.07	.17
3	115,000/1,173	.28	.65
4	100,000/2,260	.40	.94

* assumes 706ft^3 of useable space per raceway
** assumes 300 gpm per raceway (2-pass)

Each raceway will have inside dimensions of 6.5 ft. by 50 ft. and 2.5 ft. water depth, plus a freeboard of 1 ft. A2-pass system will be used in which the water from the upstream raceway can be re-aerated and used in the downstream raceway. The downstream raceway will, nonetheless, be provided with its own independent water supply for those times when the upstream raceway will be emptied. The total flow for all four raceways will be limited to 600 gpm of treated and chilled reuse water.

Figure 2, located on the next page, shows one possible arrangement for the 2-pass raceways. The raceways must be covered in order to preclude excessive temperature gain in the downstream raceway.

A screened-off 6.5 foot long settling area on the effluent end of each raceway will be provided to prevent waste and ammonia build-up from accumulating in the downstream raceway or in the water reuse system. This screened-off settling area will be totally accessible by simply removing the screen prior to harvesting the fingerlings. The sole purpose for the screen is to prevent fish from stirring-up the waste and thus allowing it to flow downstream. A separate cleaning waste (CW) pipe system, which is shown on Figure 2, will operate by gravity by simply pulling a vertical standpipe that is cast into the bottom of the raceway. This action will sluice the concentrated waste directly to the effluent pond for treatment. The relatively clean raceway overflow (± 99% of all raceway flow) will be piped to the reuse system for treatment, disinfection, and chilling if required.

The final design version of the production raceways that are sketched on Figure 2 will use baffles to create eddies and higher velocity zones, and will result in a superior cutthroat trout growout scheme for the reasons listed below:

1) Ease of cleaning walls and screens (waist-high access along 1 side of each raceway, and easy reach to far wall).
2) Truck access to one side of each raceway unit for transfer or planting operations.
3) Less stressful environment for fish (no staff climbing on raceway walls, grated walkways, or inside of raceways to perform normal cleaning and feeding duties).

4) Reduced contamination potential of raceway water due to the operations listed in 3, above, which can introduce mud or raceway waste debris carried on boots.

5) Shading of raceways will provide a better environment for the fish, and greatly reduce algae growth and cleaning requirements.

6) A safe and comfortable work environment for the staff and reduced raceway maintenance requirements.

Broodstock Raceways

Cutthroat broodstock will be collected from each of the four target tributaries. These fish will be collected as fry (2-inch to 4-inch) and grown to 20-inch in four years. Each year 100-200 fry will be collected from the same sites in the target watersheds. These fish will be individually marked and held in quarantine at the hatchery prior to being placed into one of four 6 ft. diameter early rearing tanks. They will be kept in the round tanks and closely monitored for 6 to 12 months, and will then be transferred to one of four broodstock raceways. The support of this broodstock program will be the number one priority at the new facility.

A plan and section of a possible design for the 5 ft. deep concrete broodstock raceways is sketched on Figure 3. Each raceway will be approximately 12 ft. wide by 45 ft. long, and have rounded ends to promote flow circulation. A wooden dividing baffle and two air lifts will provide a current throughout the raceway. The current could be adjusted by varying the amount of air supplied to each 6-inch airlift. This proposed raceway design will have a maximum density index (D.I.) of 0.10, which is believed conservative. The low pressure air (about 3 psi) required to operate the air lifts will be generated by a duplex air blower system housed in a nearby shed. Each one of the two air blowers will be capable of supporting the maximum air demand of all four broodstock raceways. Emergency power supply will be provided to the shed automatically during power outages.

Approximately 25 gpm of treated water, chilled to 60° F during summer months, will be supplied to each raceway when it is fully loaded with about 1,400 pounds of cutthroat broodstock (500 fish @2.8 lbs each). The two air lifts will provide supplemental aeration and up to 100 gpm of additional circulated flow within the raceway. The total raceway through-flow of 125 gpm will be equivalent to a flow index (F.I.) of 0.56, which is quite conservative, unless raceway water temperature rises above say, 65° F. Shading for these shallow broodstock raceways is essential. Shade netting could be suspended over the raceways as one possible means of temperature control during summer months. In addition, a spawning shed will be built along one side of each raceway. A screened 4-inch standpipe drain located on one side of each raceway will collect overflow for treatment and reuse. A separate 4-inch perforated PVC drain placed along the bottom will be used to clean or empty the raceway. This drain will be plumbed to the effluent pond. This proposed raceway design will result in broodstock raceways that are essentially self-cleaning.

Rainbow Trout Ponds

Approximately 15,000 rainbow trout fry, that have been hatched and started on feed in the hatchery during winter months, will be placed in one of two earthen growout ponds when they reach a size of about 1.8-inch (2.2 lbs. per 1000) in early Spring. They will be kept in the growout ponds for an additional period of about 1.5 years, at which time (year 2) they will be outplanted into the catchout ponds at a size of about 12.5 inches. A maximum of 10,000 12.5 inch rainbow trout will be raised annually for placement into the catchout ponds.

The 0.33 acre (AC) rainbow trout ponds will be approximately 75 feet wide and 190 feet long each. Total pond depth will vary from 15 ft at the supply end to 16 ft at the drain end to facilitate drainage. These deep ponds will help to attenuate summertime water temperatures and provide a more hospitable environment for the rainbow trout. The pond banks will be plastic lined and relatively steep (sloped at 2.0 horizontal to 1 vertical) to minimize maintenance and bird predation. Figure 4 is a sketch of these two ponds. It shows a 6-inch water supply pipeline and 8-inch drains. The treated and disinfected reuse water will be distributed at a rate of about 20 (+) gpm to each pond. In addition, untreated surface water from Rock Creek will be used to supplement these flows during the months of October through March, or April, depending on availability. Supplemental aeration is also envisioned for these ponds during the summer months. It must be carefully designed, however, so as not to induce destratification, and thus negate the effect of the deeper water column. Overflow from these ponds will not be reused. It will instead be piped directly to the effluent pond, and then discharged from the site.

The two 0.33 AC rainbow trout ponds described above can only be supported year-round if at least 60 gpm of continuous groundwater supply is available at the site. If, for example, only 50 gpm are found to be available, then only one pond should be constructed.

Other Improvements

The Coeur d'Alene trout production facility will require other improvements for its proper operation and security. A domestic (potable) water system, preferably with its own 5 gpm well will be essential, as will a septic waste system. A 1,200 (±) square-foot workshop/feed storage shed, that is adequately ventilated and rodent-proof will be required to properly store the sacked feed. The feed storage portion of the shed could be elevated, and a 42-inch high loading dock could be constructed to facilitate the unloading and transfer of feed. The ground-level workshop could also serve as a garage, and for the storing of expensive equipment (e.g., fish harvest pump, oxygen tanks, etc.).

Although the site appears to have adequate power supply, its remoteness and the critical nature of the life support system dictate that an emergency generator (EG) be located near the hatchery building. This EG should include an automatic transfer switch in case of power failure, and should ideally be powered by propane.

Perimeter fencing and an entry gate will be required, and as an additional precaution, the hatchery manager's residence should be located near the entry road to the facility. An effluent pond, designed to provide at least 1.5 hours of detention time at peak effluent flows (such as when a pond is drained) will mitigate the impact of the facility operations on the downstream environment. Finally, telephone lines and a PC compatible monitor and alarm system, with auto-dial capabilities for emergencies, need to be installed at the office space and at the hatchery manager's residence. All of the above, and possibly additional improvements, will be fully described during the final design of the facility.

Water Reuse System

Groundwater supply at the site is predicted to be very limited, and surface water (from Rock Creek) will be available 6 or 7 months a year. It is therefore proposed to use a 90 - 95 percent water reuse system (900 gpm total) in which ozone is used in addition to biological filters to remove toxic metabolic wastes from the process water. This method of treating reuse water in aquaculture systems has become fairly common during the past 10 years.

Owsley (1991) states that ozone is highly effective as a disinfectant and has about twice the oxidizing capability of chlorine. Ozone also reacts very quickly and is toxic on contact, killing both bacteria and viruses with equal effectiveness. Ozone, furthermore, decomposes back to oxygen and thus increases dissolved oxygen levels.

The water reuse system for the Coeur d'Alene Trout Production facility is shown schematically on Figure 5. I will consist of an inclined plate upflow clarifier/sludge settler, followed by several (up to 8) rotating biological contactors (RBC's) connected in parallel. Other biofilters that will be evaluated for possible use during final design include bead filters, and a new moving bed biofilter called a low space bioreactor (LSB). Each type of biofilter has unique advantages. For example, bead filters and LSB's will remove small particulate matter, including suspended solids, and will thus not require a clarifier. They are also much more compact than RBC's. The final selection will be based on performance, cost and ease of maintenance. As an additional precaution because of the low temperatures encountered in the biofilters (about 50 to 62° F), two activated carbon denitrifying filters will be placed downstream of the biofilters. These will function as polishing filters for about 6 percent of the total flow.

The above-described water treatment will remove small particulate matter, including suspended solids which will settle as sludge at the bottom of the clarifier. It will also convert toxic ammonia and nitrites to relatively harmless nitrates, and strip-off carbon dioxide and nitrogen gases. The treatment will be followed by ozone disinfection utilizing staged booster pumps (to better match ozone dosage to biomass loading, which varies) with mazzei injectors and two, or more ozone generators. The ozonated reuse water will be stored temporarily in an ozone contactor with froth removal (protein skimmer) apparatus. Overflow from the ozone contactor will be piped to an aeration column which discharges into a large reuse sump. A low pressure air blower will be provided to increase the efficiency of the aeration column by enabling it to function as a counterflow column. The treated and disinfected water will then be chilled and distributed throughout the facility, as is illustrated on Figure 6. This will be accomplished by means of several smaller pumps that can be used to match reuse flow to actual production needs. Alkalinity will be maintained at or above 150 mg/l calcium carbonate to increase the buffering capacity of the system, and thus prevent the pH from decreasing lower than 7.2. All of this equipment will be housed in a 2,000 - 2,400 ft^2 metal framed water treatment building located adjacent to the hatchery building.

The proposed design makes use of lessons learned during the past 10 years. For instance, ozone dosage, effectiveness of contactor, and inadequate post-treatment ozone removal have caused the majority of dissatisfactions with the earlier designs. These 3 concerns will be addressed by:

a) providing several (eventually up to three) smaller ozone generators versus a single large one (which cannot be easily regulated at low ozone demands). A side benefit of this is the redundancy afforded by using several ozone generators.

b) mazzei injectors have proven themselves more effective as ozone contactor than earlier counterflow columns utilizing fine bubble diffusers.

c) residual ozone levels do not always dissipate at a predictable rate, thus making the near-instantaneous effectiveness of counterflow aeration columns the desirable design choice.

The above and other refinements will be adopted and incorporated throughout the evolution of the water reuse system design for the proposed facility.

The water reuse system will also incorporate three water chillers. Two large units will be housed in the water treatment building and will be used to maintain desirable water temperatures in the 2-pass concrete raceways and the four broodstock raceways. A smaller chiller will be located in the hatchery building and will be used to control temperature for incubation (20 gpm) and fry rearing (140 gpm) needs.

As with most aquaculture reuse systems, much time and effort must be devoted to starting up the system. This is essential not only because it takes time for bacteria inoculation to take effect on the RBC's, but also because of the sheer volume of the culture units compared to the relatively minuscule groundwater supply. Every culture unit that will be stocked with fish must first be carefully filled with water. If this filling is not done very slowly, the limited storage capacity of the water treatment system will soon be depleted by the pumped recirculating flow—long before this same flow finds its way back to the reuse sump. This situation becomes even more crucial when large ponds need to be put into use for the first time while the cutthroat fry production raceways are in full operation. The only water available for filling a say, new broodstock raceway, will have to be robbed from the 600 gpm raceway flow, but at a rate that is approximately one-half that of the groundwater supply from the well (assuming, of course, that Rock Creek flows are not available during this time). This may become more obvious by studying Figure 6 - Schematic Flow Diagram. Note that the rainbow trout ponds (0.33 AC each and 15-ft deep) are not a consideration in this, because they are fed with water that would otherwise be wasted anyway, as it does not reenter the system.

Probable Cost

The purpose of this cost estimate is to provide current information about project budget requirements. The estimate includes cost items for facility program implementation, except for office furnishings, vehicles, laboratory equipment, computers, and other specialty items. Since there is no direct control over the cost of labor and materials in the context of the competitive bidding process, a guarantee of cost estimate accuracy cannot be given. The project cost estimate presented in Table 5 at the end of this Section has been prepared without the benefit of detailed plans and specifications. More detailed cost data will be developed during the subsequent design phases.

<u>Sources</u>

Construction costs are based on unit prices which were determined by J-U-B Engineers and JC Aquaculture Consultants based on professional experience and recent bid results for similar projects in other locations. Costs were estimated in 1999 dollars and were not escalated to represent future construction costs. No allowances were made for extra costs related to overtime work or adverse weather conditions.

Design and Construction Contingency Allowance

Any construction project can have certain unpredictable expenses, both minor and major changes in process and design, estimating errors, rapid price changes for some components, labor shortages or strikes affecting both productivity and schedules and overlooked items. To cover the cost of these unpredictable expenses, an allowance for various contingencies must be included in the total project cost at all levels of estimating. The contingency is designed to reduce project risk and should be large enough to cover all likely unforeseen and unpredictable events, conditions and occurrences. The contingency will vary according to the type of project, complexity of design, length of construction and geographical location. This allowance can be reduced as the design progresses from concept through final working documents, but the contingency must remain throughout the life of the project as a reserve for events that experience shows will likely occur.

1) Design Contingency Allowance: A design contingency allowance relative to the complexity of the design is to be included in all levels of estimates to compensate for the lack of definition, omissions, underestimates of both quantities and costs, changes in the design or corrections to erroneous assumptions. Based on past experience, a minimum design contingency applicable for this phase of the project is 10 percent.
2) Construction Contingency Allowance: A construction contingency allowance is used at all levels of estimates to cover unknown site conditions, additional costs caused by longer project schedules, lower than anticipated productivity and cost overruns due to a lack of definition in the construction documents. Based on past experience, a minimum construction contingency applicable for this phase of the project is 10 percent.

Appendix B

Site Feasibility Study
Well Test: Drawdown and Recovery

WATER QUANTITY and QUALITY RESEARCH

On October 7, 1999, long-term test pumping procedures were initiated on the recently constructed well at the potential hatchery site. During the test procedures, water level measurements were made in both the pumped well and the monitoring well. Measurements were made both during the pumping period and the recovery period. The pump was left on for approximately sixteen days and the pump was turned off on October 23 at 12:45 p.m. During the pumping period, the discharge rate was maintained at approximately 60 gallons per minute (gpm). The discharge rate was maintained successfully until the final two days of the pumping period when, for unknown reasons, the discharge rate increased to 80 gpm and 95 gpm. The measurement of recovery rates in both the wells is ongoing and data continues to be added for analysis. The resulting data, as collected during the pumping period, is presented graphically in the figure below.

There are several observations that can be made from this figure. First, the effects of the increased flow rates towards the end of the pumping period are easily identifiable in the figure as indicated by the abrupt increase in observed drawdown. In the figure, straight lines have been fitted to different portions of the data from both wells. These lines match the data relatively well and it can be seen that at approximately 2000 minutes, straight lines with a different slope are needed to match the data. This change in slope is a response of the aquifer to a change in conditions encountered by the cone of depression. In this case, it is interpreted as a negative boundary. This matches the available information regarding the geology in the area, which indicates that the site is not only bounded on one side, but most likely on three sides. The collected data indicates a single boundary. However, if the pump was not turned off, it is our belief that additional negative boundaries would have been encountered and these boundaries would result in increased drawdown over time. Another significant observation that can be made from the data is that steady-state conditions were not achieved. If steady-state conditions were achieved, drawdown in both of the wells would have stabilized and would not continue to increase with time. If we had achieved steady-state conditions, it would have provided an indication of the sustainable yield of the aquifer. The fact that we did not reach these conditions, indicates that recharge over the cone of depression is less than the pumping rate of 60 gpm, resulting in continued drawdown.

When the pumping period was ended on October 23, the collection of recovery data began. As stated previously, this data is still being collected. The recovery data that has been collected to date for both the pumping well and the monitoring well is presented in the two figures below as well as the pumping data that was presented in the previous figure.

Again, significant observations can be made from these two figures. Under ideal aquifer conditions, nearly full recovery should occur when the recovery period is equal to the pumping period (i.e. if the pumping period is 10 days, almost all of the recovery should occur 10 days after the pump is shut off). At the time of this report, the recovery period duration was less than the pumping duration. However, the recovery data pattern seen to date can be used to estimate what the recovery would be when the recovery period is equal to the pumping period. When this is done, the drawdown in the pumping well is estimated at 3.2 feet less than the pre-pumping static condition. The same procedure also estimates the drawdown in the monitoring well as 3.2 feet less than pre-pumping static conditions. Recovery in both wells should continue to be monitored to verify these values. If continued monitoring verifies these estimates, it indicates that the aquifer was essentially being "mined" during the test pumping activities and the recharge rate to the aquifer is insufficient to maintain a pumping rate of 60 gpm for 6 months/year. The total volume of water removed from the aquifer during the test pumping was 1,530,000 gallons and this resulted in 3.2 feet of "mining". A direct correlation with the scenario of pumping 60 gpm for six months per year (15,768,000 gallons) equates to nearly 33 feet of "mining" per year. At this rate, the well(s) would become inoperational after a period between one and two years. This correlation is not perfect and does not consider boundary effects that were not encountered during the testing period, but will likely be encountered during actual operation. However, it does provide a strong indication that this aquifer does not have the potential to provide the desired flow rates over an extended period of time.

In the two figures below, the same recovery data is presented in a different format. In these figures, t/t' is plotted on the X-axis, where t is the total time since pumping started and t' is the time since the pump was shut off.

As with the pumping data, straight lines have been fitted to the data where possible. Again, a definite change in slope is identifiable for both the pumping well and the observation well. As with the pumping data, this is interpretted as a negative boundary. Of special note, is the location of the 0-drawdown intercept as indicated by the straight lines fitted to the data. In both cases, the 0-intercept is projected to fall on a value of t/t' of less than 1. This is indicative of a limited aerial extent aquifer. It does not necessarily indicate that the aquifer itself is of limited extent. It can also indicate that the area of the aquifer that can contribute to the flow of water to the well is of limited extent. In either case, it does indicate that the aquifer has a limited potential to provide significant quantities of water over time.

From the data collected, the aquifer properties can be estimated. The testing regimen followed for this project actually provides several estimates of the aquifer properties that are presented in the table below.

	Step Drawdown Monitoring Well	Long-term Pumping Pumping Well	Long-term Pumping Monitoring Well	Recovery Pumping Well	Recovery Monitoring Well
Transmissivity (gpd/ft)	10,500	6,500	6,250	6,200	7,000
Storativity	0.0008	N/A	0.0004	N/A	0.0003

The values shown in the table appear reasonable considering the geologic materials and environment. All of the values calculated from the long term testing are in relative agreement. The values calculated from the step drawdown test are higher than the other calculated values. The reason for this observation can be explained by using information collected from extensive testing of basalt aquifers completed at the groundwater research site in Moscow, Idaho. Testing of basalt aquifers here have shown that during the early portion of testing there appears to be a component of leakage to the aquifer. This effect is typically short lived and would explain the slightly higher values calculated for the aquifer properties.

Using these values for the aquifer properties, image well theory was used in an effort to reproduce the observations made in the monitoring well during both the pumping and recovery period. During this process, the property values for the aquifer were changed within the range established in the above table until the actual observed data could be closely imitated. The results of these efforts are displayed in the figure below.

As can be seen in the figure, the image well model provides a reasonable match to the observed data through most of the pumping and recovery period. In order to obtain a match to the observed data, modification of the pumping rates used in the model to represent recovery were necessary. Under ideal conditions, the rate should be the same as it is to represent withdrawal. However, when this was done the recovery data could not be closely matched. Through a trial and error process, it was determined that limiting the recovery pumping rate to 88% of the withdrawal rate produces the closest match to the data. This is somewhat of an unconventional approach and does introduce a certain degree of error into any predictions that extend significantly into the future.

There is one area where the observed data varies from the image well prediction. This occurs at a time of approximately 32,000 minutes. At this time, the water level in the observation well was observed to rise at an increased rate and then actually decrease and then approach the values predicted by the image well model. This is an unusual observation and we are not aware of any natural conditions that could cause this observation. This is approximately the same time that the pump was removed from the pumping well, but the magnitude and duration of the anomaly are such that the removal of the pump is not a realistic cause for the observations. Other factors such as human error and changes in barometric pressure were considered as possible causes for the observations, but after evaluation appeared insufficient to explain the observations.

Using the same image well model, other pumping scenarios were evaluated to estimate the long term potential for the aquifer to supply water for use at the proposed hatchery. It is significant to note that the image well model presented here was created using a single negative boundary that was easily identifiable from the test pump data. However, it was previously noted that there are most likely additional negative boundaries that would be encountered during longer term pumping activities. The existence of these boundaries could cause long term predictions, using the same image well model, to underestimate drawdown. However, a review of the two long-term scenarios presented below, indicate that the aquifer in question is not capable of supplying the necessary flow rates without including the additional boundaries. The inclusion of these additional boundaries would still show that the desired volumes of water could not be reasonably obtained and they would actually increase the predicted drawdown.

The first pumping scenario that was evaluated consisted of two wells that are placed 200 feet apart and pumped alternately at 60 gpm on 30 day alternating cycles. Two wells were used in this scenario to represent the most likely operational set-up that would be used if it were believed that the aquifer had the potential to serve as the sole water supply source for the hatchery. The resulting drawdown predictions for this scenario are presented graphically on the next page.

In this figure, the effect of the alternating pumping cycles is readily apparent. It can also be seen that water levels would continue to decline over time. Based on the construction of the new well, there is approximately 70’ of available drawdown. As can be seen in the figure, this value would be exceeded in approximately 500 days. This is much less than the acceptable design life.

The second scenario that was evaluated is exactly the same as the first, but after six months both of the wells are shut off. This was done to evaluate the impacts of using groundwater for only six months per year. Currently, this is the most likely option that will be pursued. The resulting drawdown graph is presented below.

Again the cyclic drawdown pattern is clearly evident and it appears that pumping rates could be maintained for at least one 6-month period. However, it can be seen that after one year the water levels are not predicted to fully recover. This figure estimates that at one year, when the pumps will need to come back on for the next 6-month pumping period, there is still approximately 18 feet of drawdown. At this rate, the pumps would go dry at the end of the second year of pumping or possibly in the middle of the third year.

Each of the scenarios and approaches presented to this point has shown that the aquifer has a low potential to meet the requirements for the proposed hatchery. There are a number of problems associated with extrapolating data collected during test pumping procedures to make long term predictions. Often there are conditions that cannot be identified from the data that may affect any predictions. There are also limitations and errors that result from the governing equations that are used to make the predictions themselves. These equations are constrained by a number of assumptions that are required to develop the equations and these assumptions may not hold true under actual conditions. However, everything that we have seen to date indicates that the potential for the aquifer in question to provide the necessary volume of water over time is low. Considering the importance of the proposed hatchery and the significant cost associated with its construction, it is our belief that additional options should be evaluated at this time to ensure that any constructed facility will have an adequate supply of groundwater.

Up to this point, all of the analysis has been based on a pumping rate of 60 gpm either year round or 6 months per year. J-U-B has shown that the potential to achieve this is low, but has not addressed how much water we feel the aquifer can reliably supply. In order to estimate this quantity on an annual basis, we must take a broader look at the aquifer and combine what we have learned from drilling, the pumping tests, well logs, and other sources. For this analysis, J-U-B has relied heavily on information provided by Dr. Dale Ralston relating to recharge mechanisms and rates, and specific storage values for basalt. Much of the information provided by Dr. Ralston is based on research conducted in the Moscow-Pullman basin. The proximity of the Moscow-Pullman basin to this site and the similarity in geology should equate to a valid correlation. However, the fact that no extensive research has been conducted in the area provides no numerical basis to compare the two systems.

The first step in this process is to determine what area of the aquifer can possibly contribute water to the well. The proposed location of the hatchery is located in the northwest corner of the aquifer. This is the upgradient portion of the aquifer. Based on geologic maps, it appears that the total area of the aquifer is approximately 15 square miles. The aquifer appears to be bounded on the north, south and west by bedrock materials. The east side of the aquifer appears to be bounded by Chatcolet Lake. Plummer Creek flows through the area and the lack of obvious springs along this creek tends to indicate that the discharge point for the aquifer is probably the lake. The elevation of the lake varies, but can generally be considered to be around an elevation of 2125 feet. This can be considered as a constant head boundary. At the proposed hatchery location, the static water level in the well was measured as approximately 32 feet below land surface. Using a quadrangle map to estimate the surface elevation of 2740 feet results in a water surface elevation of 2708 feet. This shows that there is a relatively steep gradient in the aquifer between the well and the lake. If we assume that the gradient is linear between these two points, we can then estimate the area that we feel can realistically contribute flow towards the well. If we assume that water levels in the well can be lowered 70 feet by pumping, we can estimate that the gradient can be reversed towards the well for a distance of approximately 3,200 feet. Using this radius and approximating the negative boundaries created by changes in geology, we can calculate the contributing area to be approximately 0.30 square miles.

Using this area, we can then use values that have been generated for recharge in the Moscow-Pullman basin to estimate the sustainable yield of the aquifer from the proposed hatchery site. Recent research has indicated that recharge to the Moscow-Pullman basin is from deep, area wide percolation of approximately 1 inch per year. Applying this recharge rate to the area of 0.30 square miles results in a volume of 5,215,000 gallons per year, which equates to a constant pumping rate of approximately 10 gpm and a six-month pumping rate of 20 gpm. Even though these values are based on information taken from another basin, they provide the best estimate of a sustainable yield. This method does not include any water that is taken from storage. Taking water from storage would increase the volume that could be pumped, but there is a price to pay. For any water that is taken out of storage there is a resulting drawdown in the aquifer. If water is continued to be taken from storage, water levels will continue to decline over time until water levels are drawn below the pumps.

At this point it has been shown that one cannot withdraw the necessary quantity of water from the aquifer in question and J-U-B has estimated that an on-site well system can provide 20 gpm for six months per year from the aquifer beneath the proposed site. A minimum of 60 gpm for six months per year has been defined as the minimum hatchery requirements. This leaves an additional 40 gpm for six months per year that must be taken from another source.

In lieu of selecting another hatchery site, alternative groundwater supplies must be identified that can provide the necessary additional flow. The area north of the site contains another aquifer system that may have the ability to provide the necessary flows. The area around Worley appears to contain another separate aquifer that extends over a much larger area than the aquifer found in the basalt near Plummer. This aquifer is also found in the basalt rock. The larger area of the aquifer in the Worley basin should provide sufficient quantities of water to meet the hatchery requirements.

J-U-B has preliminarily identified the area along Conkling road as being a likely area to tap into this second aquifer. It appears, both from geologic maps and review of well logs, that in this area we can complete a well that will draw water from the Worley basin. Additional test wells and test pumping activities will need to be completed in this area to verify that the necessary flows can be met. If it is found that a well field along Conkling road cannot meet the flow requirements, it may be necessary to move even farther north and repeat the process again. The costs associated with pumping water this distance to the hatchery may be significant and careful consideration of all factors including financial, operational and cultural must be weighed before a final decision is made.

Another issue that should be considered before making the decision to pursue a water source in the Worley basin is water quality. Samples taken from the recently constructed well show that the water quality of the aquifer below the hatchery site is relatively good. This is likely the result of the site's location relative to the entire aquifer and the small size of the aquifer. These two factors tend to indicate that the water we are pumping is relatively young in geologic terms and this often equates to high quality. In the Worley basin, however, the groundwater has been in the system for a much longer period of time and this can often increase the quantity of dissolved constituents. Groundwater quality issues are a well-known problem in the Worley basin. This does not necessarily preclude the use of groundwater from the Worley basin, but may require that treatment processes be incorporated into the final design of the hatchery facility.

Appendix C

Genetic Analysis Report:
Coeur d'Alene basin westslope cutthroat trout

GENETIC ANALYSIS OF WESTSLOPE CUTTHROAT TROUT IN TRIBUTARIES OF COEUR D'ALENE LAKE

PROGRESS REPORT WTSGL99-101

to

The Coeur d'Alene Tribe

Wild Trout and Salmon Genetics Laboratory

JANUARY 1999

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ABSTRACT

We used non-lethal sampling and the polymerase chain reaction to amplify species-specific nuclear DNA markers differentiating westslope cutthroat trout (*Oncorhynchus clarki lewisi*), rainbow trout (*O. mykiss*) and their hybrids. Samples from 16 sample sites in tributaries to Coeur d'Alene Lake, Idaho were analyzed. Six sites contained samples of westslope cutthroat trout with no evidence of hybridization. The remaining ten sites included at least one hybrid individual. Three of these locations contained a single hybrid individual. When present, hybridization occurs at a low level and most likely represents episodic events of migration into these systems by rainbow trout or hybrid individuals.

INTRODUCTION

Westslope cutthroat trout (*Oncorhynchus clarki lewisi*) have declined throughout their range (Allendorf and Leary 1988). Many of the remaining populations have been negatively impacted by hybridization with non-native trout. Intentional introduction of other salmonids has been commonplace throughout the species range. These introductions include non-native forms of rainbow trout (*O. mykiss*) and other subspecies of cutthroat trout that readily hybridize with westslope cutthroat trout. Various anthropogenic actions, such as hydroelectric dam construction, over grazing, and timber harvest, have dramatically altered the habitat of these fish, exacerbating the effects of hybridization.

Identification of non-hybridized populations is an important first step toward preservation and rehabilitation of native westslope cutthroat populations (Campton 1987). These data are necessary to direct management actions such as removal of exotic species or construction of barriers to prevent invasion by introduced species. In addition, if a native westslope brood stock is to be established, genetic confirmation of the purity of the founding stock for that program is imperative.

We have developed a non-lethal method to identify hybrids between cutthroat trout and rainbow trout. This technique, known as PINES, uses polymerase chain reaction (PCR) primers complementary to interspersed nuclear elements to amplify DNA fragments specific to each species (Spruell et al. 1997; Spruell et al. submitted; Smithwick et al. in prep). Using this method, we can determine the species composition of populations without causing the substantial mortality associated with other techniques.

In this report, we present our results for the initial phase of the genetic analysis of westslope cutthroat trout in tributaries of Coeur d'Alene Lake, Idaho. We describe the use of PINEs to detect hybrids in 16 locations and summarize the results of the analysis. These data will be incorporated by the Coeur d'Alene tribe to manage the native fish fauna in Coeur d'Alene Lake and its tributaries.

MATERIALS AND METHODS

Samples were obtained from 16 sites by the Coeur d'Alene tribe. Fin clips were stored in 95% ethanol and transported to the Wild Trout and Salmon Genetics Lab at the University of Montana for analysis.

Primers complementary to various interspersed elements were synthesized, incorporating a fluorescent label to allow visualization (Table 1). Products were amplified under the following conditions. PCRs contained approximately 25 ng of genomic DNA, 1 µl 10X Perkin-Elmer PCR buffer, 4.5 mM $MgCl_2$, 0.2 mM of each dNTP, 5.0 pmoles of primer and 0.5 U Taq. Reactions were completed in a MJ Research PTC-100 thermal cycler using the following profile: 3 min. at 95°C, followed by 30 cycles of 91°C for 1 min., 60°C for 1 min., 72°C for 2.5 min., then 72°C for an additional 2.5 min. Products were stored at 12°C until electrophoretic analysis was completed.

Amplified products were size fractionated on a 4.5% denaturing polyacrylamide gel for 1 hour and 15 minutes at 65 watts. DNA fragments were visualized using a Hitachi FMBIO-100™ fluorescent imager.

Gels were visually inspected for fragments previously determined to be diagnostic for each *Oncorhynchus* subspecies (Smithwick et al. in prep). The size of each of these fragments was confirmed using the MapMarkerLOW™ size standard (BioVentures Inc.) and FMBIO data analysis software (Version 6.0, Hitachi Software). Samples of each species previously confirmed to be pure (Spruell et al. 1997) were also included on each gel to ensure consistent scoring across all gels. Each population was screened with a minimum of two PINE primer combinations.

RESULTS

The identification of each individual was determined by the number of bands diagnostic for each species or sub-species. Six of the 16 sample locations contained westslope cutthroat trout and no individuals containing markers diagnostic for rainbow trout (Table 2). The remaining ten sample sites contained at least one hybrid individual (Table 2). Three of these locations (Lake Cr. #2, Whitetail Cr., and S. E. F. Benewah Cr.) contained a single hybrid fish.

DISCUSSION

Our analysis indicates fish from six sample sites (Table 2) contain westslope cutthroat trout and no individuals containing markers diagnostic for rainbow trout or any other subspecies of cutthroat trout. In addition, all individuals from these populations contained all markers diagnostic for westslope cutthroat. These markers provide greater than 95% confidence that hybridization exceeding a level of 1% would be detected in this analysis.

We did not detect evidence of extensive hybridization in any of the samples analyzed. This pattern of hybridization is consistent with relatively infrequent episodic hybridization events. The maximum number of hybrid individuals (28%) found was in Cherry Creek. That sample also had the highest level of hybridization. On average, hybrid individuals contained 37.5% of the rainbow trout markers. However, these same individuals also contained 100% of the markers diagnostic for westslope cutthroat. If this population had experienced high levels of hybridization for an extended period of time, we would expect to see the loss of westslope markers. Thus, even in Cherry Creek it appears as though hybridization events occur episodically not continually.

Three locations (Lake Creek #2, Whitetail Cr., and S.E. F. Benewah Cr.) contained a single hybrid individual. We cannot eliminate the possibility that the markers found in these individuals are naturally found at a low level in westslope cutthroat trout. However, these individuals did not all contain the same diagnostic marker. We also did not observe these markers in any individual from the six "pure" populations. Finally, these markers were observed with other rainbow trout markers in other hybrid individuals. These three fish will be investigated in more detail using microsatellites however, it is most probable that they are hybrids.

In the next phase of this study, we will analyze all samples using microsatellite loci. These loci are ideally suited to detect population differentiation at small geographic scales. Although these markers are rarely diagnostic, the distribution of allele sizes found in different species within a limited geographic area are often non-overlapping.

It is likely that during the course of the microsatellite analysis, additional hybrid individuals will be identified. However, it is unlikely that a substantial number of such individuals will be found.

The results of this study indicate that restoration of the native westslope cutthroat in Coeur d'Alene Lake and its tributaries is promising. None of the sample sites have high proportions of hybrid individuals. Those hybrids that are present in the system appear to be hybridized at a low level. This pattern of hybridization is consistent with infrequent migration of rainbow trout or hybrids into the system.

REFERENCES

Allendorf, F. W. and R. F. Leary. 1988. Conservation and distribution of genetic variation in a polytypic species, the cutthroat trout. Conservation Biology 2:170-184.

Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. American Fisheries Society, Bethesda, Maryland.

Campton, D. E. 1987. Natural hybridization and introgression in fishes, methods of detection and genetic interpretations. In *Population Genetics and Fishery Management* , ed. N. Ryman and F. Utter (University of Washington Press, Seattle, WA), pp. 161-192.

Greene, B. A., and J. E. Seeb. (submitted) SINE and transposon sequences can be used to generate high-resolution DNA fingerprints, "SINE-prints", which exhibit faithful Mendelian inheritance in pink salmon (*Oncorhynchus gorbuscha*). Marine Molecular Biology and Biotechniques

Jeffreys, A. J., V. Wilson, and S. L. Thein. 1985. Hypervariable 'minisatellite' regions in human DNA. Nature (London) 314:67-73.

Kido, Y., M. Aono,T. Yamaki, K. Matsumoto, S. Murata, M. Saneyoshi, and N. Okada. 1991. Shaping and reshaping of salmonid genomes by amplification of tRNA-derived retroposons during evolution. Proceedings of National Academy of Science USA 88:2326-2330.

Smithwick, J. W. P., K. L. Knudsen, P. Spruell, and F. W. Allendorf. (in prep.) Identification of rainbow trout, cutthroat trout, and their hybrids using PCR primers complementary to interspersed nuclear elements.

Spruell, P., K. L. Knudsen, J. W. P. Smithwick, and F. W. Allendorf (1997) Genetic monitoring of westslope cutthroat trout in the Northfork of the Clearwater River. Annual Report to the Nez Perce Tribe.

Spruell, P. , K. L. Pilgrim, B. A. Greene, C. Habicht, K. L. Knudsen, K. R. Lindner, J. B. Olsen, G. K. Sage, J. E. Seeb, and F. W. Allendorf (in press) Inheritance of nuclear DNA markers in gynogenetic haploid pink salmon. Journal of Heredity.

Spruell, P., M. L. Bartron, N. Kanda, and F. W. Allendorf (submitted.) Use of PINE-PCR (Paired interspersed nuclear element-PCR) to detect hybrids between bull trout (*Salvelinus confluentus*) and brook trout (*S. fontinalis*).

Table 1. Primer sequences used to generate species-specific PINE fragments.

Primer	Sequence	Reference
Fok I 5'	CCAACTGAGCCACACGGGAC	Kido et al. 1991
Hpa I 5'	AACCACTAGGCTACCCTGCC	Kido et al. 1991
Hpa I 3'	TGAGCTGACAAGGTACAAATC	Kido et al. 1991
Sma I 5'	AACTGAGCTACAGAAGGACC	Kido et al. 1991
Tc 1	TGATTGGTGGAGTGCTGCAG	Greene and Seeb 1997
33.6	TGGAGGAGGGCTGGAGGAGGGCAC	Jeffreys et a. 1985

Table 2. Sample locations, sample size, number of hybrid indivduals, and average level of hybridization for westslope cutthroat trout in Coeur d'Alene Lake tributaries.

GENETIC ANALYSIS OF WESTSLOPE CUTTHROAT IN TRIBUTARIES OF COUER D'ALENE LAKE

FINAL REPORT WTSGL99-106

to

The Coeur d' Alene Tribe

Wild Trout and Salmon Genetics Laboratory

JUNE 1999

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SUMMARY

We used seven microsatellite loci to determine the genetic relationships among westslope cutthroat trout collected from 16 sample locations in tributaries to Lake Coeur d' Alene, Idaho. These sample locations have statistically significant differences in allele frequencies at one or two loci. However, the overall genetic distances as estimated using two techniques are quite small. These results are consistent with a system in which gene flow occurs but not at a sufficient rate to make these populations genetically homogeneous. The differences in allele frequencies are probably the result of genetic drift in small populations.

INTRODUCTION

Westslope cutthroat trout (*Oncorhynchus clarki clarki*) are declining throughout their range. Westslope cutthroat trout in tributaries to Coeur d' Alene Lake, Idaho are no exception to this trend. Historically substantial populations exhibiting both resident and migratory and life histories occurred in many of these tributaries. Genetic analyses can be used both to estimate the level of hybridization within a population and to assess the relationships among samples collected at various locations. These genetic data can then be incorporated into a management strategy for the species.

A major threat to the persistence of all native westslope cutthroat populations is hybridization with non-native rainbow trout (*Oncorhynchus mykiss*). The available data indicate that hybrid swarms can form rapidly after the two species begin to interbreed. Once such a hybrid swarm is formed, elimination of the exotic genes is virtually impossible.

We examined 16 populations of westslope cutthroat trout from Coeur d' Alene Lake, Idaho to assess their hybrid status (Spruell et al. 1999). Although some hybrid individuals were identified, most of the populations contained few hybrids. These results are not consistent with persistent hybridization or the presence of a hybrid swarm. Based on these results, recovery of native westslope cutthroat in this system is promising.

An accurate description of the genetic population structure of a species is necessary for effective conservation and management. This requirement is especially true for small populations that may be at risk of extinction. Managing multiple reproductively isolated populations as a single breeding unit may break down adaptive distinctions. Conversely, treating sub-populations from a larger metapopulation as independent biological units may overestimate the impending threat to each population and may therefore lend a false sense of urgency to intensive management actions.

In this report, we present results of a microsatellite survey intended to assess the genetic relationships among westslope cutthroat sampled from 16 tributaries to Coeur 'd Alene Lake , Idaho. These data will be used by the Coeur d' Alene Tribe to manage the native fish fauna in Coeur d' Alene Lake and its tributaries.

MATERIALS AND METHODS

Samples

Samples were obtained from 16 sites by the Coeur d' Alene Tribe. Fin clips were stored in 95% ethanol and transported to the Wild Trout and Salmon Genetics Lab at the University of Montana for analysis. Based on our previous work (Spruell et al. 1999) some of those samples were of hybrid origin. However, in most cases the number of hybrids was low. Those few hybrid individuals should not dramatically alter the allele frequencies determined at microsatellites. Therefore, we analyzed all samples.

Microsatellites

Seven microsatellite loci were amplified in an MJ Research PTC-100 thermocycler using the profiles and conditions of the individuals initially describing each locus (Table 1). Amplified products were size fractionated on 7% denaturing polyacrylamide gels and visualized using a Hitachi FMBIO-100 fluorescent imager. Product sizes were determined using MapMarkerLOW™ size standards (Bio Ventures Inc.) and Hitachi FMBIO software (version 6.0). Each gel also included previously amplified individuals to ensure consistent scoring across all gels.

Data Analysis

Allele frequencies, heterozygosities, deviations from Hardy-Weinberg expectations, exact probability of population differentiation and F-statistics were calculated using GENEPOP (Raymond & Rousset 1995). We used allele frequencies and the Cavalli-Sforza and Edwards (CSE) chord distance option of PHYLIP (Felsenstein 1992) to construct a matrix of genetic distance for all pair-wise population comparisons. We then used the UPGMA algorithm in PHYLIP to construct a dendrogram of the populations. The dendrogram was visualized using TREEVIEW PCC (Page 1996). We completed a principal components analysis using the covariance matrix of allele frequencies using MINITAB (release version 11) omitting the largest allele at each locus to account for the non-independence of allele frequencies within a locus (for review see Cavalli-Sforza et al. 1993).

RESULTS

All seven microsatellite loci analyzed were polymorphic in Coeur d' Alene Lake westslope cutthroat trout (Table 2 and 3). After correction for multiple tests (Rice 1989), statistically significant deviations from expected Hardy-Weinberg genotypic proportions were observed at a single locus (*OMY301*) in the Bull Creek sample. Relative heterozygosities over these loci ranged from 0.235 in the Bull Creek sample to 0.421 in the Whitetail Creek sample. In most cases, the most common two alleles were shared by all populations.

Pair-wise comparisons of allele frequencies indicate statistically significant ($P<0.005$) differentiation between many pairs of populations for at least one locus (Table 3). This differentiation is reflected in an index of gene diversity (F_{ST}) of 0.038.

Both the UPGMA dendrogram (Fig. 1) and the plot of principle components one and two (Fig. 2) indicate that other than a slight tendency for Lake Creek samples to group together, there is little correlation between geographic location and genetic similarity. In fact, two of the most genetically similar populations based on the CSE chord distance estimator (Benewah 1 and Bozard) are among the most geographically distant pairs.

DISCUSSION

Allelic distributions, estimators of pair-wise divergence, and significance measures indicate little correlation between geographic distance and genetic differentiation. Based on this overall lack of geographical structuring, an island model of migration (see pp. 192-194 in Hartl and Clark 1997for review) does not seem unreasonable for these populations. Assuming an island model and an F_{ST} of 0.038, the estimated rate of gene flow among populations is approximately seven individuals per generation (Allendorf & Phelps 1981). However, this estimate is based on past conditions. The current level of migration may be reduced since the number of migrants (Nm) decreases in proportion to the reduction in population size. That is, for a constant migration rate (m), reducing the population size (N) will cause a corresponding decrease in the number of migrants per generation. Nevertheless, sufficient migration to prevent the loss of rare alleles has probably taken place in the recent past.

The level of genetic differentiation estimated in Coeur d' Alene cutthroat trout by microsatellites appears to be considerably less than estimates from other areas obtained using allozymes. For example, across the range of the species, the estimated F_{ST} is 0.333 (R. F. Leary, pers. comm.). Within the South Fork of the Flathead River, F_{ST} was estimated to be 0.150 (R. F. Leary, pers. comm.). Both of these values were based on allozymes in which genetic distinction should arise more slowly. Thus, the microsatellite-based F_{ST} estimates presented in this report appear to be quite low for westslope cutthroat trout. However, levels of heterozygosity appear to be reasonably high, minimizing the possibility that inbreeding depression is currently a problem.

Samples of westslope cutthroat from Coeur d' Alene Lake tributaries differ significantly in allele frequencies but have low estimated values of genetic distance. This may appear to be a contradiction. However, differentiation may occur even with some level of gene flow. One migrant per generation is sufficient to prevent the loss of rare alleles. More migrants are necessary to produce a genetically homogeneous population. If the migration rate is below this threshold, genetic drift will alter allele frequencies at random loci. This appears to be the case in these samples. In most cases each pair of populations is differentiated by one or two loci. Thus, it appears that within the recent past, these populations were reasonably large and somewhat interconnected. Yet, they are currently declining in number.

Hatchery supplementation has been suggested as one alternative to increase the number of westslope cutthroat trout in tributaries of Coeur d’ Alene Lake. Once the goals of a supplementation project have been established, efforts to increase the numbers of naturally spawning populations must be undertaken considering both the genetic and demographic risks. If it is determined that hatchery supplementation is viable option, the brood stock source, the duration of the supplementation program, and a mechanism to monitor the effects of hatchery fish should be identified. This monitoring program should first and foremost determine if the hatchery program is having a beneficial effect on fish numbers, justifying the genetic and demographic risks.

In the case of Coeur d’ Alene Lake westslope cutthroat trout, sample sites appear genetically quite similar. Thus, risk that local adaptations will be eliminated due to outbreeding depression is lessened. However, given the complex life history of migratory fish in this system, some concern must remain. We cannot be certain that migratory forms from one area will thrive in another. Assuming only one brood stock will be created, the best alternative is probably to collect fish from multiple source populations and use this mixture as the brood stock. However, care must be given to insure that the collection of brood stock does not jeopardize the existence of the source populations.

The greatest genetic risks of a properly managed hatchery in this system are domestication of the brood stock and inadvertent introgression with rainbow trout. We have characterized many of the tributaries that might serve as brood stock. Therefore, managers can avoid using individuals from hybridized populations. However, some routine genetic monitoring should be initiated to identify and eliminate any hybrid individuals that may be included in the brood stock. The brood stocks should also be maintained in a manner to maximize the number of breeders in order to avoid inbreeding depression and minimize domestication.

The long-term solution to the decline of westslope cutthroat trout in Coeur d’ Alene Lake is to identify and correct the causes of the decline. In many cases, these causes are probably related to habitat degradation. If habitat rehabilitation will take longer than westslope cutthroat trout will persist in these tributaries, more intensive short-term management, such as hatchery supplementation could be considered. However, these actions should be directed toward a goal of recovery of self-sustaining natural populations.

ACKNOWLEDGMENTS
We thank Jonathan Miller and Dan Spencer for technical assistance.

REFERENCES

Allendorf, F. W. & Phelps, S. R. 1981. Use of allelic frequencies to describe population structure. Canadian Journal of Fisheries and Aquatic Sciences 38: 1507-1514.

Cavalli-Sforza, L. L., Menozzi, P., & Piazza, A. 1993. The history and geography of human genes. Princeton University Press, Princeton NJ.

Estoup, A., Presa, P., Kreig, F., Vaiman, D., and Guyomard, R. 1993 (CT)n and (GT)n Microsatellites: a new class of genetic markers for *Salmo trutta* L.(brown trout). Heredity, **71**: 488-496.

Felsenstein, J. 1992. PHYLIP (*Phylogeny Inference Package*) Version 3.5C. Department of Genetics, SK-50, University of Washington, Seattle, 98195, USA.

Hartl. D. L. & Clark, A. G. 1997. Principles of population genetics. Sinauer Associates, Inc., Sunderland, MA.

Page, R. D. M. 1996. TREEVIEW: An application to display phylogenetic trees on personal computers. Computer Applications in Bioscience 12: 357-358.

Raymond, M. & Rousset, F. 1995. GENEPOP (version 1.2): population genetics software for exact tests and ecumenicism. Journal of Heredity 83: 248-249.

Rice, W. R. 1989. Analyzing tables of statistical tests. Evolution 43: 223-225.

Slettan, A., Olsaker, I., and Lie, O. 1996. Atlantic salmon, *Salmo salar*, microsatellites at the SSOSL25, SSOSL85, SSOSL311, SSOSL417 loci. Anim. Genet. **27**: 57-64.

Spruell, P., Knudsen, K. L., Miller, J., and Allendorf, F. W. 1999. Genetic analysis of westslope cutthroat trout in tributaries of Coeur d' Alene Lake. Progress Report WTSGL99-101 to the Coeur d' Alene Tribe.

Figure 1: UPGMA dendrogram of sample locations based on Cavalli-Sforza and Edwards chord distance.

Figure 2. Plot of principal components one and two calculated using seven microsatellite loci. Distance between points is representative of genetic similarity.

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Angelo,

You may want to add the attached figure and this letter to the final report as an addendum. The dendrogram is based on 6 of the 7 microsatellites we used. These additional data do not change any interpretation in our report, but they do illustrate how little genetic differentiation we observed in the Coeur d' Alene samples.

The additional samples are from the North Fork Clearwater in Idaho (Bostonian and Sawtooth), and a tributary that flows into Lake Koocanusa near the Canadian border (LYoung & UYoung). It was surprising to me that the two sample from Young Creek are almost as genetically divergent as the entire sample set from Coeur d' Alene Lake. Those Young creek samples were probably collected within 6 miles of one another. It is always possible that we are looking at a life history difference there, but the level of differentiation is striking nonetheless.

The Sawtooth sample was virtually fixed at every locus (i.e. there is almost no genetic variation within that sample). I talked to Dana Weigel with the Nez Perce tribe this morning & she is not aware of any barriers on Sawtooth Creek nor anything else that would cause the observed lack of genetic variation. There are a few more fish from a single year class than we normally shoot for but there are definitely 2 or 3 year classes represented in the sample.

Kathy and I are hoping to analyze a few more populations from the Northfork Clearwater to see what patterns emerge. We are a bit surprised by the lack of divergence in Coeur d' Alene.

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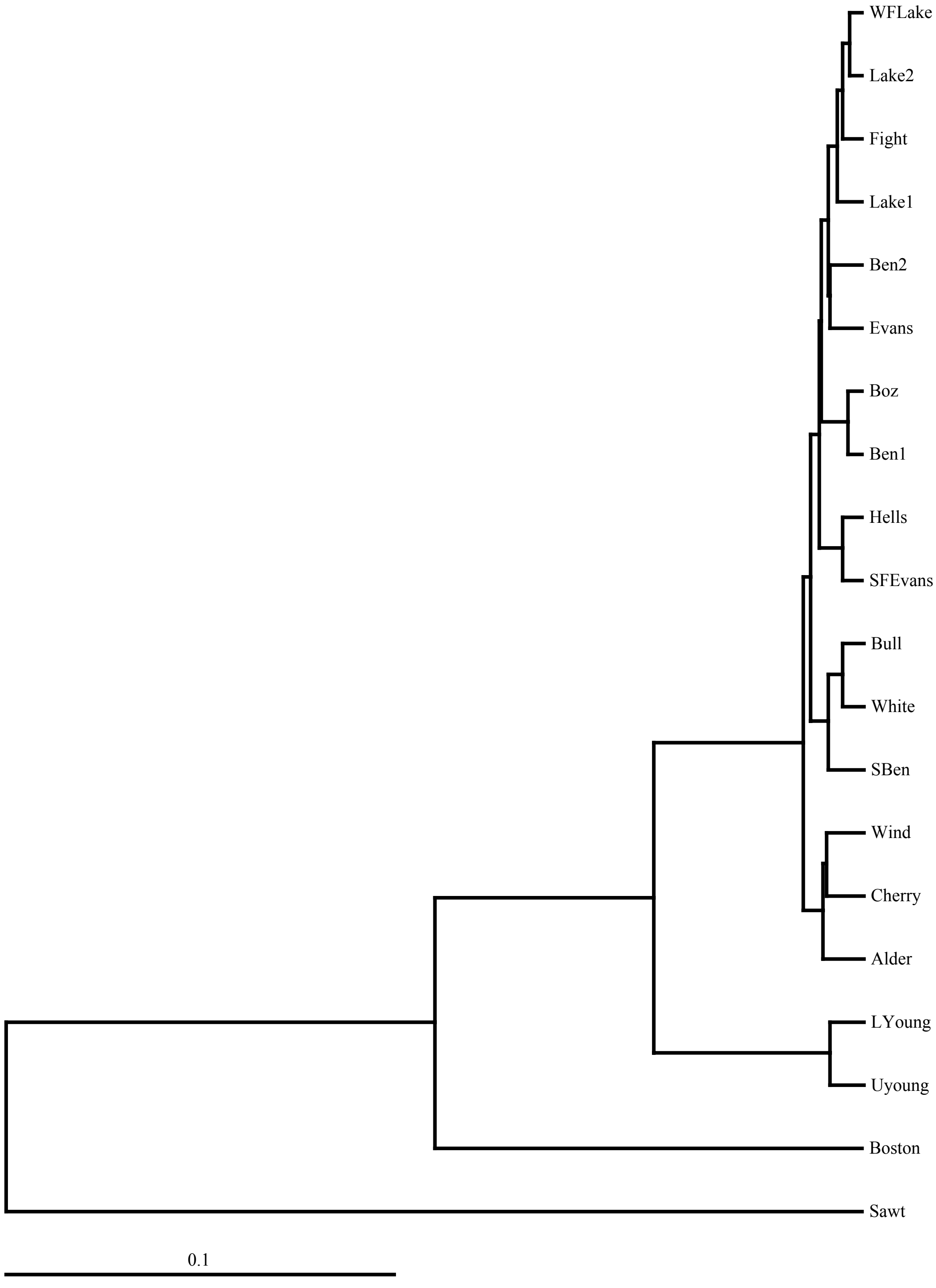
WT&SGL, DBS
University of Montana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Appendix D

Goals, policies and recommendations for construction and operation of federally funded Artificial production facilities.

This is a summary of the goals, policies and recommendations composed of ideas from several regional studies and reports as well as from regional workshops on this topic. . Primary among these sources was the Draft NPPC *Artificial Production Review Vol. I Report and Recommendations of the Northwest Power Planning Council* (1999), *Return to the River* Independent Scientific Group (1996), Report of the National Fish Hatchery Review Panel (1994), *Upstream: salmon and society in the Pacific Northwest* National Academy of Science (1996), and the *Supplementation in the Columbia Basin* Regional Assessment of Supplementation Project (RASP) Bonneville Power Administration (1992).

Excerpt from Draft NPPC ***Artificial Production Review Vol. I Report and Recommendations of the Northwest Power Planning*** *Council* (1999)

Policies to Guide the Use of Artificial Production

The scientific principles, legal mandates, and purposes provide the backdrop for policies on the use of artificial production. Decisions to use the tool of artificial production, and how to use it, need to be made in a scientifically sound manner to achieve management objectives by addressing specific biological problems. The following policies are intended for that purpose — to be applied to allow for a detailed understanding and evaluation of artificial production in the basin.

These policies need to be considered in the context of the natural conditions of the Columbia River Basin as it now exists. In most places, this ecosystem is significantly altered from the time when Europeans began inhabiting the basin more than 150 years ago. This means that fish populations adapted to the original "natural" conditions of the Columbia basin may not be the same as those that are now or could be naturally produced. This does not mean that habitat will not be improved to be more productive for native fish populations and species, but only that the original habitat conditions are not achievable in the foreseeable future. Therefore, when these policies speak of natural conditions, they are referring to current or foreseeable improvements in the existing, altered ecosystem. Production for harvest is a legitimate management objective of artificial production within this context. However, to minimize the particular adverse impacts on natural populations associated with harvest management of hatchery populations, harvest rates and practices must reflect or be dictated by the requirements to sustain naturally spawning populations.

1. **The manner of use and the value of artificial production must be considered in the context of the environment in which it will be used**.[1]

Artificial production must be used consistent with an ecologically based scientific foundation for fish and wildlife recovery. A number of considerations are embedded in this policy, including:

- The success of artificial production depends on the quality of the environment in which the fish are released, reared, migrate and return.
- Artificial production provides protection for a limited portion of the life cycle of fish that exist for the rest of their lives in a larger ecological system, albeit altered, that may include riverine, reservoir, lake, estuarine and marine systems that are subject to environmental factors and variation that we can only partially understand.
- The success of artificial production must be evaluated with regard to sustained benefits over the entire life cycle of the produced species in the face of natural environmental conditions, and not evaluated by the number of juveniles produced.

[1] This policy should be implemented in a manner that addresses SRT guidelines 1-2 and 4-13.

- Domestication selection is the process whereby an artificially propagated population diverges in survival traits from the natural population. This divergence is not avoidable entirely, but it can be limited by careful hatchery protocols such as those required by policies in this report.
- For actions that mitigate for losses in severely altered areas, such as irrevocably blocked areas where salmon once existed, the production of non-native species may be appropriate in situations where the altered habitat or species assemblages are inconsistent with feasible attainment of management objectives using endemic species.

2. **Artificial production must be implemented within an experimental, adaptive management design that includes an aggressive program to evaluate benefits and address scientific uncertainties.**[2]

The ability of artificial production to provide sustained management and biological benefits over the entire life cycle and throughout the ecosystem, and to minimize adverse effects to naturally spawning populations, remains a topic of debate.

3. **Hatcheries must be operated in a manner that recognizes that they exist within ecological systems whose behavior is constrained by larger-scale basin, regional and global factors.**[3]

The performance of hatcheries should mirror the dynamics and behavior of the larger system. Expectations of constancy in either returns or management are unrealistic.

- Management of artificial production, and the expectations of that management, should be flexible to reflect the dynamics of the natural environment. Production and harvest managers should anticipate large variation in hatchery returns similar to that in natural production.
- The management and performance of individual facilities cannot be considered in isolation but must be coordinated at watershed, subbasin, basin and regional levels, and must be integrated with efforts to improve habitat characteristics and natural production where appropriate.

4. **A diversity of life history types and species needs to be maintained in order to sustain a system of populations in the face of environmental variation.**[4]

Recent scientific reviews have indicated that effective restoration of fish populations to the Columbia River may depend far more on protecting and restoring biological diversity and habitat than simply increasing abundance. A central management consideration in all artificial production should be to minimize adverse effects on biological diversity and, to the extent possible, to use the artificial production tool to help reverse declines in biological diversity.

5. **Naturally selected populations should provide the model for successful artificially reared populations, in regard to population structure, mating protocol, behavior, growth, morphology, nutrient cycling, and other biological characteristics.**[5]

Natural selection hones the characteristics of fish populations against the template of the natural environment. These dynamics shape natural populations so that they collectively have the characteristics necessary to sustain the species in the face of environmental variation. These naturally selected

[2] This policy should be implemented in a manner that addresses SRT guidelines 16-19.
[3] This policy should be implemented in a manner that addresses SRT guidelines 1-2 and 4-13.
[4] This policy should be implemented in a manner that addresses SRT guidelines 1-2 and 4-15.
[5] This policy should be implemented in a manner that addresses SRT guidelines 1-2 and 4-13.

populations thus provide a model that should at least guide the efforts to sustain successful artificially reared populations, even if replicating all natural conditions is not feasible. The use of locally adapted or compatible broodstocks, and a corresponding reduction in the use of population transfers and non-endemic populations, is a significant part of this policy.

The implications of this policy may differ somewhat depending on whether the focus is to improve hatchery survival, avoid adverse impacts on natural populations, or use artificial production to try to restore naturally spawning populations. How this policy applies in any particular situation should be tested using the following three working hypotheses:

- With regard to increasing the survival of the hatchery population itself, the working hypothesis is that mimicking the incubation, rearing and release conditions of naturally spawning populations will increase survival rates after release into the natural environment. Some efforts to mimic natural rearing processes, such as the use of shading, are generally accepted as appropriate practices. Uncertainty lies in how far managers should go in mimicking natural rearing conditions in an effort to improve survival, especially considering the increasing cost, the difficulty of some measures, and the possibility of declining benefits. In addition, there are certain situations in which the survival of hatchery fish appears to be enhanced by *not* mimicking natural release size or migration times. Decisions to deviate from the biological characteristics of the naturally spawning population should be documented through an explicitly stated biological rationale and carefully evaluated. In addition, the efficacy of programs that mimic natural populations should continue to be tested to reduce uncertainty.

- With regard to the possibility of adverse impacts of artificial production on naturally spawning fish, much of the recent literature suggests that using local broodstocks and mimicking natural rearing conditions will reduce the impacts of hatchery populations on naturally spawning populations and the ecosystem. There is a counter-hypothesis that, at least in some situations, it is best for artificial production managers to avoid mimicking the release times, places, and conditions of natural populations to avoid harmful competition, predation and other adverse interactions. Again, any decisions to deviate from the biological characteristics of the naturally spawning population should be documented through an explicitly stated biological rationale and carefully evaluated.

- The final working hypothesis, which applies to hatchery production for the *restoration* purpose, is that through the use of locally adapted or compatible broodstocks and natural rearing and release conditions, hatchery production can benefit or assist naturally spawning populations. This is the least established hypothesis of the three, and the one most in need of experimental treatment and evaluation.

6. **The entities authorizing or managing a hatchery facility or program should explicitly identify whether the artificial propagation product is intended for the purpose of augmentation, mitigation, restoration, preservation, research, or some combination of those purposes for each population of fish addressed.[6]**

Existing determinations of the purpose(s) for all hatchery facilities and programs should be revisited within the next three years, and periodically thereafter. These evaluations should take place *only* in the larger context of decisions on fish and wildlife goals and objectives for the Basin, provinces and subbasins (*see* the next part of the report for more detail). Also, a decision to build or continue a hatchery

[6] This policy should be implemented in a manner that addresses SRT guidelines 3, 9 and 14.

for a specified purpose must include an explicit identification of the underlying biological problem, an explicit determination that the assumptions or conditions relating to that hatchery purpose do exist, and an explicit expectation of the duration of the program:

- A decision identifying a hatchery as a "permanent" *mitigation* hatchery should be accompanied, for example, by an explicit identification of the permanently lost habitat that it replaces.
- A decision identifying a *restoration* hatchery should include, for example, an explicit determination that suitable restored habitat exists or will soon exist for re-seeding. It should also include a statement of the expected duration of the program, by which it is expected the natural population will be rebuilt and the facility withdrawn (or continued with a different identified purpose).
- Similarly, a decision identifying a *preservation/conservation* hatchery should include, for example, an explicit determination that the underlying habitat decline or other problem-threatening extirpation will be addressed and how. This decision should also include a statement of the expected duration of the program, the time by which the program will be evaluated to determine if it is a success (meaning the time by which it is expected that natural processes can once again sustain the population, and the facility withdrawn or converted to another identified purpose) or a failure (meaning that it is time to end or reorient the program).

7. **Decisions on the use of the artificial production tool need to be made in the context of deciding on fish and wildlife goals, objectives and strategies at the subbasin and province levels.**

While decisions on the use of artificial production are best made in the subbasin context, these decisions also need to be consistent with basinwide and regional considerations and objectives. The monitoring and evaluation framework for artificial production facilities and programs should also have a regional/basinwide aspect as well as specific subbasin elements.

8. **Appropriate risk management needs to be maintained in using the tool of artificial propagation.[7]**

As critically important as monitoring and evaluation are, it is most difficult, and in some cases still impossible, to monitor and evaluate the effects we most care about, such as complex ecological interactions, ocean effects and interactions, and the relationship between changes in hatchery practices and ultimate adult returns. The same is true of other aspects of the complex biological problem of fish and wildlife recovery, so the risk management strategies applied to artificial production should be generally consistent with those applied to other stages of the life-cycle and to other factors affecting the status of populations.

9. **Production for harvest is a legitimate management objective of artificial production, but to minimize adverse impacts on natural populations associated with harvest management of hatchery populations, harvest rates and practices must reflect or be dictated by the requirements to sustain naturally spawning populations.[8]**

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[7] This policy should be implemented in a manner that addresses SRT guidelines 16-17.
[8] This policy should be implemented in a manner that addresses SRT guideline 17.

10. **Federal and other legal mandates and obligations for fish protection, mitigation, and enhancement must be fully addressed.**

Efforts to address these mandates and obligations have historically been unsuccessful, at least in large part. The principles, policies and purposes identified here are not intended to diminish or otherwise affect these mandates and obligations. At the same time, it is recognized that these mandates and obligations can be, and might be, altered, by the appropriate authorities in response to this document or other events.

E. Performance Standards[9]

Hatchery operations can be evaluated against the set of general policies described above. But more can be gained by translating the general policies into more specific and detailed performance standards and then evaluating hatchery operations against those standards. For example, the general policy calling for the biological characteristics of natural populations to be the model for artificial production can be further developed into a number of more specific operational standards.

Over the last few years, a number of agencies, inter-agency teams or scientific panels have developed partial or comprehensive sets of guidelines and standards to be used to evaluate artificial production. The guidelines in the Science Review Team's final report are but one example; the most comprehensive effort is the Integrated Hatchery Operations Team's (IHOT) *Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries* from 1995. All of these efforts have been sensitive to the modern concerns for minimizing harm to natural populations. At the same time, it is possible that some of the standards developed even in the recent past are not consistent with the principles and policy statements that the Council recommends in this report.

For this reason, participants in the Artificial Production Review, working with Council staff and facilitators, organized an ad hoc workgroup to pull together a set of consistent performance standards that can be used to evaluate to hatchery operations in the future. Attached to this report is a draft of the performance standards that the group developed, using the policies and purposes in this report, the guidelines in the Science Review Team's report, and the IHOT policies as a foundation for these draft standards. The performance standards are still draft form, as the Council intends to seek peer and public review before making a final recommendation.

End of excerpt.

Goals, policies and recommendations for operation of artificial production facilities in the Columbia Basin summarized from the other documents listed.

- Facility production programs and supplementation activities will be evaluated relative to their objectives and their impacts on natural ecosystems.
- The success of the program is directly tied to the quality and quantity of the environment into which the fish are released, therefore, the use of artificial production and supplementation will be directly linked to watershed conditions and habitat improvements.

- The success of the facility will depend on the ability to maintain physical and behavior attributes of the fish that enhance survival in the natural environment, and to avoid domestication. Therefore, genetic considerations will be addressed in the use of artificial production.
- Technology resembling natural incubation and rearing conditions will be used for artificial production of fish including:
  a. incubation in substrate and darkness
  b. incubation at lower densities
  c. rearing at lower densities
  d. rearing with shade cover available
  e. exposure to in-pond, natural-like habitat
  f. rearing in variable, higher velocity habitat
  g. non-demand food distribution during rearing
  h. exposure to predator training
  i. minimize fish-human interaction
  j. acclimation ponds at release sites
  k. volitional emigration from release sites
  l. artificial production incubation and rearing will use the natal stream water source whenever possible
- The facility will be designed and engineered to represent natural incubation and rearing habitat in order to simulate incubation and rearing experiences complementary with those of naturally produced fish in natural habitat.
- Genetic and breeding protocols consistent with local stock structure will be developed and applied to minimize potential negative effects of artificial production on naturally producing populations and to maximize the positive benefits of artificial production.
- We will use large breeding populations to minimize inbreeding effects and maintain what genetic diversity is present within the population.
- Artificial production strategies will mimic natural population parameters in size, maturation and timing of migrating juveniles so to synchronize with environmental selective forces.
- Artificial production will use ambient natal stream habitat temperatures to reinforce compatibility with local environments.
- Release of artificially produced fish will consider the numerical limits of the biological limits of the receiving stream, including consideration of members of the release population that do not migrate. Considerations will include impacts on the naturally producing fish residing in the system as well as life history requirements of the cultured stock.
- The program will avoid using strays in breeding operations to avoid stock hybridization.
- Restoration of extirpated or weak populations will follow genetic guidelines to maximize the potential for re-establishing self-sustaining populations. Once restored, subsequent effort will concentrate on allowing selection to work, by discontinuing introductions.
- Introductions of non-native species in areas where the non-native species currently does not occur will not be allowed.
- Recent scientific reviews have indicated that effective restoration of salmonids to the Columbia River may depend far more on protecting and restoring biological diversity than simply increasing abundance. A diversity of life-history types and species of salmonids is necessary to sustain a system of populations in the face of environmental variation. A central management consideration for the facility will be to minimize adverse effects on biological diversity and, to the extent possible, use the artificial production tool to help reverse declines in biological diversity.
- Natural selection hones the characteristics of fish populations against the template of the environment. This dynamic principle shapes natural populations to collectively have the characteristics necessary to sustain the species in the face of environmental variation. The use of

locally adapted or compatible broodstocks, and a corresponding reduction in the use of stock transfers and non-endemic stocks is a part of this policy.

- Production for harvest is a management objective of the facility. However, to minimize the particular adverse impacts on wild populations associated with harvest management of hatchery populations, harvest rates and practices will reflect or be dictated by the requirements to sustain naturally spawning populations.
- Risk management strategies applied to facility operations will be consistent with those applied to other stages of the life cycle and to other factors affecting the status of populations.

Appendix E

Estimated Construction Cost

ENGINEERS OPINION OF PROBABLE CONSTRUCTION COST FOR THE COEUR D'ALENE TRIBE TROUT PRODUCTION FACILITY.

J-U-B ENGINEERS, Inc. Suite 722, 422 W. RIVERSIDE AVE., SPOKANE, WA 99201 (509) 458-3727

ENGINEERS OPINION OF PROBABLE CONSTRUCTION COST

DATE: 16-Sep-99

PROJECT:
COEUR D'ALENE TRIBE TROUT PRODUCTION FACILITY BASED ON CONCEPTUAL DESIGN RPT

PROJECT DESCRIPTION:
TROUT PRODUCTION FACILITY

TO:

OWNER PROJ. NO.: J-U-B PROJ. NO.: 70180

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	BASE BID
1.	Groundwater Supply (On-site)				
	Wells	2	EA	$15,000.00	$30,000.00
	Pipeline	1,800	LF	$16.00	$28,800.00
	Electrical	1	LS	$20,000.00	$20,000.00
2.	Groundwater Supply (Off-site)				
	Wells	2	EA	$20,000.00	$40,000.00
	Pipeline	11,000	LF	$16.00	$176,000.00
	Electrical	1	LS	$25,000.00	$25,000.00
	Pipe Jack Railroad Right-of-Way	1	LS	$20,000.00	$20,000.00
	Right-of-way/Easement Acquisition	1	LS	$5,000.00	$5,000.00
3.	Rock Creek Diversion Structure				
	Concrete Vault Sump	1	LS	$20,000.00	$20,000.00
	Control Vault	1	LS	$5,000.00	$5,000.00
	Electrical Controls	1	LS	$20,000.00	$20,000.00
	Piping	1	LS	$15,000.00	$15,000.00
4.	Access Roadways (Partial Upgrade)	1	LS	$25,000.00	$25,000.00
5.	Hatchery Building (3,150 S.F.)(Breakdown below)	3,150	SF	$80.00	$252,000.00
	Slabs, Footings and Erection ($29.00)				
	Stud Walls & Finish ($15.00)				
	Drop Ceilings ($ 8.00)				
	Bathroom Fixtures ($10.00)				
	Windows & Screens ($ 5.00)				
	HVAC ($ 7.00)				
	Electrical & Lighting ($ 6.00)				
	Stainless Sinks/Faucets	3	EA	$2,000.00	$6,000.00
6.	Hatchery Building Special Construction				
	Floor Trench & Grating	120	SF	$25.00	$3,000.00
	Case Work, Tile Work & Water	1	LS	$5,000.00	$5,000.00
	Concrete Landing, Ramps, Bollards	1	LS	$5,000.00	$5,000.00
	Outdoor Concrete Pad	400	SF	$12.50	$5,000.00

	Concrete Pad Roof & Columns	400	SF	$12.50	$5,000.00
	Loft Storage	250	SF	$16.00	$4,000.00
*7.	Hatchery Life Support				
	Tanks, Troughs & Incubators	1	LS	$27,000.00	$27,000.00
	Distribution Piping & Valves	1	LS	$22,000.00	$22,000.00
	Chillers, U.V., Filters & Pumps	1	LS	$52,500.00	$52,500.00
	Headboxes & Aeration Column	1	LS	$8,500.00	$8,500.00
8.	Water Treatment Building (2,100 SF)				
	Metal Building, Slabs & Footings	1	LS	$125,000.00	$125,000.00
	Sheet Subototal				$949,800.00

ENGINEERS OPINION OF PROBABLE CONSTRUCTION COST

DATE: 16-Sep-99

PROJECT:

COEUR D'ALENE TRIBE TROUT PRODUCTION FACILITY BASED ON CONCEPTUAL DESIGN RPT

PROJECT DESCRIPTION:

TROUT PRODUCTION FACILITY

OWNER PROJ. NO.: J-U-B PROJ. NO.: 70180

ITEM NO.	DESCRIPTION	SCHEDULE OF VALUES			
		QUANTITY	UNIT	UNIT PRICE	BASE BID
	Heating & Ventilation	1	LS	$8,000.00	$8,000.00
	Electrical & Lighting	1	LS	$27,000.00	$27,000.00
	Stainless Sink & Faucet	1	EA	$2,000.00	$2,000.00
	Concrete Landing, Ramps, Bollards	5	EA	$500.00	$2,500.00
*9.	Water Treatment Equipment				
	Ozone Generators & Destruct	1	LS	$36,000.00	$36,000.00
	Ozone Contactors/Protein Skimmers	1	LS	$80,000.00	$80,000.00
	Biofilters	1	LS	$73,000.00	$73,000.00
	Oxygen Generators	2	EA	$4,000.00	$8,000.00
	Chillers	1	LS	$76,000.00	$76,000.00
	Counterflow Column & Blowers	1	LS	$10,000.00	$10,000.00
	Pumps, Motors & Sumps	1	LS	$37,000.00	$37,000.00
	Piping & Valves	1	LS	$30,000.00	$30,000.00
	Alkalinity & PH Drip	1	LS	$8,000.00	$8,000.00
	Activated Carbon System	1	LS	$10,000.00	$10,000.00
10.	Production Raceways				
	4 Raceways 50' x 6.5' x 3.5'	4	EA	$28,000.00	$112,000.00
	Aluminum Screens & Baffles	1	LS	$10,000.00	$10,000.00
	Aeration Columns	2	EA	$3,500.00	$7,000.00
	Reuse & Waste Drains	1	LS	$12,000.00	$12,000.00
	Yard Piping	1	LS	$19,000.00	$19,000.00
	Raceway Roof & Columns	2,200	SF	$10.00	$22,000.00
	Grading & Paving	1	LS	$15,000.00	$15,000.00
11.	Broodstock Raceways				
	4 Raceways 45' x 12' x 5'	4	EA	$17,500.00	$70,000.00
	Aluminum & Wood Baffle	4	EA	$2,000.00	$8,000.00

	2 Air Blowers, Shed, Airlifts	1	LS	$13,500.00	$13,500.00
	Reuse & Waste Drains	1	LS	$12,000.00	$12,000.00
	Yard Piping	1	LS	$27,000.00	$27,000.00
	4 Harvest Sheds	4	EA	$3,500.00	$14,000.00
	Shade Netting	1	LS	$15,000.00	$15,000.00
	Grading & Surfacing	1	LS	$4,500.00	$4,500.00
12.	Rainbow Trout Ponds				
	Clearing & Grubbing	1	LS	$2,500.00	$2,500.00
	Earthwork - Cut & Fill	5,000	CY	$5.00	$25,000.00
	Pond Liner	2	EA	$14,000.00	$28,000.00
	Concrete Steps & Harvest Pond	2	EA	$3,500.00	$7,000.00
	Supply & Drain Piping	1	LS	$19,000.00	$19,000.00
	Airlifts & Air Piping	1	LS	$6,000.00	$6,000.00
	Grading & Surfacing	1	LS	$7,500.00	$7,500.00
13.	Workshop/Feed Storage (1,200 SF)				
	Metal Buildings, Slabs & Footings	1	LS	$52,500.00	$52,500.00
	Heating & Ventilation	1	LS	$4,000.00	$4,000.00
	Sheet Subtotal				$920,000.00

ENGINEERS OPINION OF PROBABLE CONSTRUCTION COST

DATE: 16-Sep-99

PROJECT:

COEUR D'ALENE TRIBE TROUT PRODUCTION FACILITY BASED ON CONCEPTUAL DESIGN RPT

PROJECT DESCRIPTION:

TROUT PRODUCTION FACILITY

OWNER PROJ. NO.: J-U-B PROJ. NO.: 70180

ITEM		SCHEDULE OF VALUES			
NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	BASE BID
	Electrical & Lighting	1	LS	$5,000.00	$5,000.00
	Concrete Dock & Steps	1	LS	$3,000.00	$3,000.00
14.	Effluent Pond				
	Earthwork	1	LS	$15,000.00	$15,000.00
	Pump Sump & Piping	1	LS	$15,000.00	$15,000.00
	Sludge Pump & Motor	1	LS	$10,000.00	$10,000.00
	Electrical Service	1	LS	$5,000.00	$5,000.00
	Herbaceous Plants	1	LS	$1,500.00	$1,500.00
15.	Emergency Generator (125 kw)	1	LS	$45,000.00	$45,000.00
16.	Monitor & Alarm System	1	LS	$7,000.00	$7,000.00
17.	Electrical Power Distribution	1	LS	$5,000.00	$5,000.00
18.	Pad Mounted Transformers	1	LS	$4,000.00	$4,000.00
19.	Potable Water System	1	LS	$7,000.00	$7,000.00
20.	Septic Tank System	1	LS	$15,000.00	$15,000.00
21.	Manager's Residence				
	3 Bedroom Premanufactured Home	1	LS	$50,000.00	$50,000.00

	Foundation, Driveway, Utilities	1	LS	$20,000.00	$20,000.00
22.	Parking Area & Access Road	1	LS	$40,000.00	$40,000.00
23.	Landscaping & Handicap Access	1	LS	$8,000.00	$8,000.00
24.	Entry Gate & Perimeter Fence	2,000	LF	$10.00	$20,000.00
25.	Clearing, Grubbing & Reseeding	5	AC	$1,500.00	$7,500.00
26.	Acclimation Ponds	4	EA	$36,000.00	$144,000.00
	Sheet Subtotal				$427,000.00
	Subototal				$2,296,800.00
	10% Design Contingency				$229,680.00
	10% Construction Contingency				$229,680.00
	Grand Total				$2,756,160.00

*** COULD BE OWNER-SUPPLIED**